THE

Practical Teacher

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'Knowledge is proud that he has learned so much,
Wisdom is humble that he knows no more.'—COWPER.

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Hygiene.

BY ALFRED CARPENTER, M.D, M.R.C.P. (LOND.).

HOW TO PREVENT DISEASE IN SCHOOL AND HOME.

IN former volumes of the PRACTICAL TEACHER we have rehearsed the principles which regulate 'Health at School.' We have rapidly gone over the common diseases and accidents of school-life; we have suggested the best means to be taken to cure or alleviate such diseases and accidents as soon as they come under the notice of the schoolmaster; we have also detailed the principles of hygiene, and the organic laws upon which they are founded in all the usual directions. These, from a sanitary point of view, include a consideration of the requisite food for health, of diet, water, air, scavenging, sewering, the disposal of the dead, shelter, clothing, personal hygiene, and the common meteorological conditions which influence health.

We now propose to consider, in more minute detail than was possible in preceding papers, the principles which apply to the prevention of disease in school and home life. (1st) As to the possibility of its origin at all; and (2nd) if it does arise, then to inquire as to how it may be limited in its operation, and how the seed-germs, or to speak more correctly, '*contagium particles*,' which may have been developed by a given case can be destroyed, or so dwarfed as to prevent their capacity to fructify in the future so as to bear fruits in the bodies of other persons, especially as may be the case among the (too often) closely-packed children of an elementary or other large school.

It is the custom for people to look upon certain diseases as necessary contingencies which must follow from the fact of children being alive; that they will have measles, whooping-cough, or scarlatina, as naturally as they have to cut their teeth and change their tone of voice. This is an assumption not founded upon fact. Neither children or adults need have such diseases, though at present their incidence must be provided for. The manifestation of disease of a certain kind indicates a neglect of sanitary law, just as the growth of weeds in a garden indicates the neglect of one of the first principles of horticulture. '*One year's seeding*' requires '*seven years' weeding*' to eradicate the consequences of horticultural neglect, so the profuse scattering of the germs of evil from certain forms of disease give rise to a further necessity for an activity in repression in the future, which would not have been necessary if the first case had been dealt with in a rational and scientific manner upon truly hygienic principles.

What is Disease?—Let us ask what is meant by the term 'disease.' It is not an entity, a thing, a defined condition; it may simply be the absence of ease, of comfort, or of happiness. Disease is not limited to known conditions, like to fevers, or cancer, or abscess, but it is anything or everything which disturbs the comfort, the pleasure of living, or that causes uneasiness to either mind or body, to either function, faculty, or healthy habit of life. That which troubles or disturbs the serenity of the human frame, either in mind or body, tends to bring on disease by being antagonistic to ease. Disease is therefore an action set up in the frame in resistance to some disturbing cause, which puts healthy action out of gear. It may even consist in the establishment of conditions which are requisite to be endured before health can be again secured. A consideration, therefore, of the conditions which give rise to disease is a consideration of all those means whereby the body and mind are kept in a comfortable state. The discomforts and uneasinesses of life should be kept in abeyance, or altogether prevented, if health is to be perfect, and there must also be an obedience to hygienic laws. We have, therefore, a wider field than at first sight may appear to be contained in our title. There is something more than a question of the adoption of commonly understood hygienic measures, such as of proper drainage, and the provision for pure air, and a pure water supply. For instance, let the head of the school come into the class-room with a headache, let him speak angrily to his class, or unjustly to one of its members, there is uneasiness in the minds of the pupils, and a state antagonistic to health is at once produced, which renders them less able to do the work which is before them. The condition of the master reflects itself upon the nervous system of his pupils, and reduces their ability to resist other influences which may be abroad. It is quite possible

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for a small impediment or slight interference with a given action to divert the results of that action into another channel. A floating contagium particle may find a resting-place and fructify to-day, because the system is not at ease, whilst yesterday it could resist its influence and meet it with impunity, because the mind was not disturbed. The influence of matter over matter is known, and can be measured, but that of mind over matter is among the unknown and yet potent powers which exist in the universe, and upset all calculations based upon material agencies. Our field of observation takes in, therefore, a much wider basis than that involved in a stamping out of infectious disorders, or the prevention of their introduction, although these latter are the *raison d'etre* of our writings.

We propose now to take into consideration the conditions which should exist in all schools, by means of which infectious and other preventable diseases may be kept in abeyance, or if they gain entrance, to show clearly the methods which must be taken to stamp them out, by laying down at the commencement of our task, the conditions which are necessary to be observed. We shall afterwards consider all those points which are of importance in the management of a large school, by which the health of the children may be preserved; and, lastly, give some details as to the measures required to balance the wear and tear of nerve force, and the means to be taken to equally develop the muscular, the osseous, and the nervous systems of the body.

As to the Hospital or Sick House.—The arrangements which are required in large schools are much more complex than those which may hold good in smaller establishments. Those which are necessary for a large pauper establishment will be somewhat different to those which should be in force in such schools as Eton or Winchester. The hospital requirements in great public-schools are not quite such as would necessarily be submitted to in private adventure boarding-schools, whilst it would be quite impossible for those establishments which are for middle-class education, and without endowments or rating power, to provide the means which large public and aristocratic schools can easily enforce. There are differences, again, in the regulations which should be applied in the case of day-schools, whether elementary or advanced, and which are much more difficult to enforce than is the case in public or private adventure boarding-schools. Each kind will have to be considered in its turn. Those schools in which *leave out* is granted most easily will have more difficulties to contend with than those in which 'leave' is difficult to obtain. Those, again, which are situated in a sparsely populated district will have considerable advantages over those which are stationed in the midst of or near to a dense population. The difficulties are greater the more closely the children can associate with outside influence, whether it be by means of chance visitors, or capacity for the boys or girls to find their way into the confectioner's shop (tuck-shop) or the various haunts connected with surreptitious amusements or pleasures of any kind.

Infectious Wards a Necessity.—The first condition to be observed in arranging for a large boarding-school will be that the managers provide sufficient accommodation for ordinary emergencies. Suppose we require to provide against the contingencies which may arise in a public school containing 1,000 boys—I take that number for convenience of calculation (a simple sum will show what is requisite for 200)—the ordinary mortality among 1000 children should not be more than three or four in the 1000 per annum. We may also consider that for each one dying twenty will be seriously sick in the course of the year. We have here a calculation as to average sickness, sixty to eighty annually, which is less than two per week. But it is found in practice that sickness does not come in this regular manner, and there will be eight or ten boys, or even more, presenting themselves at one time, whilst there may be a clean bill of health at another. Epidemics occasionally arise and upset all arrangements which are based upon averages. A school with a thousand beds must have a sick house capable of holding not less than twenty ordinary cases of sickness, and with room for forty if emergencies arise; but let us suppose that measles, scarlatina, or other epidemic influences appear, where are the cases to be put? Some arrangements must be carried out by means of which such cases of sickness may be isolated from all others, and this consideration requires that there shall be two distinct hospitals, or at least two blocks which can be quite separated from each other. As regards the infectious wards, they should be, when in use as such, capable of being entirely isolated from the school and its surroundings, especially from the playgrounds. The sick house may overlook the playground, but the infectious wards must be quite separated so that the windows may not be a means whereby infective germs may reach the boys at play. It will be best therefore to arrange that the infectious wards be placed at some distance from the main buildings, and altogether to the rear of the ordinary sick house, or else on the upper floor of the latter, with an entirely different way of approach, and with windows opening in a direction opposite to the playground, and not towards the main buildings of the school. There should be room for twenty beds, but under ordinary circumstances only two or three should be kept ready for use, and these not necessarily in the rooms themselves. They may be kept in use in the ordinary dormitories, so that when required they may be (from common use) well aired, and not likely to be unfit for occupation. Even the beds belonging to the sick boys—that is, those which they are accustomed to occupy when well—might be taken down and conveyed to the infectious wards in the first instance when a new case or cases are discovered. If an epidemic appears likely to arise daily provision may be made for the cases, in the wards devoted to infectious diseases. It is important that sickening children should not be chilled by being put into an altogether unused bed. The infectious wards should have such offices as may prevent unnecessary intercourse with other parts of the establishment; and nurses must be told off at once, who shall have no other duties than to attend upon the patients in the infectious wards. The food for the patients may be brought from the kitchen of the main building provided it can be done without unnecessary intercourse. Norwegian kitchens (as they are called) being useful means for conveying the food from the kitchen to the sick children, unless all the necessary arrangements for cooking can be carried out on the premises, which is the better course. The Norwegian kitchens are proper forms of pans, which are placed

in boxes lined with felt, and closely covered with similar material, and which keep the prepared food at its proper temperature until it is removed from the covering. There should be great difficulties placed in the way of anything being conveyed back again from the wards to the main building; nothing should go back, no matter what its nature, until it has been marked as disinfected. It should be the duty of the chief nurse to see that this is done, and that the mark is placed upon the utensil or other article by a proper attendant, not the nurse. The cubic capacity of the infectious ward must be much larger than that which is required for an ordinary hospital. Each adult requires at least from 1500 to 2000 cubic feet of air space, but for children 800 to 1000 feet will be sufficient, according to age, provided the ventilation is well attended to, but children over fourteen require as much air as adults. There should be room for eight or ten beds in each of two or more wards. The floor of the room should be formed, if possible, of solid blocks of wood closely laid upon concrete or asphalte, like to those now in use in elementary schools, so as to entirely prevent those chinks into which *débris* of any kind can by any possibility find its way. The floor should also be thoroughly well bees-waxed and kept perfectly clean; it should be carefully wiped down every day by means of a damp (not wet) cloth, so that no dust shall collect on it, especially, as it is prone to do, under the beds of the patients. The walls should be covered with Parian cement, or painted in the lower six feet upon Portland cement as if panelled; so as to obviate the chance of absorption of impurities; the upper part may be Portland cement well distempered, and the ceiling so constructed that it may be lime-whited after each time that the room is occupied. There should be no cornices, no shelves, or other places in which lodgments of fluff or dust can take place. The window frames should be flush with the walls for the same reason. The windows themselves should rise to within a few inches of the top of the ceiling, so that there may not be a great space in the upper part of the room, the air of which might be deprived of ventilation. The ward should have abundance of light, and if possible there should be through ventilation, that is, there should be windows on both sides of the room, which, when open, shall allow a through draught. I prefer a good fireplace with open fire to hot-water pipes for warming purposes; a combination of both is the best. The entrance to the ward should be by means of a distinct staircase not communicating with wards which are not similarly used, or which cannot be completely isolated. There should be two small rooms right and left of the entrance, the one for the use of the nurses, the other for the detention of a case, or for purposes which may become necessary in the treatment of the sick. These rooms should be supplied with hot and cold water, and a properly-arranged sink in indirect communication with the sewer. The further end of the ward should have the usual w.c. arrangements, but these should be so constructed that all *débris* must necessarily be disinfected before it becomes discharged into the sewer system, if there be one, but the sewage from infectious wards is best kept out of a sewer. The w.c. should have a small anteroom with through ventilation between it and the ward. It would be more prudent to use sawdust or charcoal, in a well-constructed earth-closet, and to have the results destroyed by heat. By such means the chance of infecting the soil and spreading the disease in the future would be entirely obviated. It is necessary to have a portable earth-closet in the ward itself. This should be supplied with peat, charcoal, or sawdust, so that the results after use may be rapidly burnt in a properly-constructed furnace.

(To be continued.)

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Popular Mythology.

BY THE REV. SIR GEORGE W. COX, BART., M.A.,
Author of 'Tales of Ancient Greece,' 'Mythology of the Aryan Nations,' etc.

[These papers are designed for our youngest readers. Used as themes for composition work, they will be found invaluable.]

IV.—(*continued.*)

AMPHIARAOS, one of the great prophets in Greek mythology, is said to be a descendant of the seer Melampous, or a son of Apollo and Hypermnestra, and to have been one of the hunters of the Calydonian boar. He married Eriphyle, the daughter of Adrastos, with whom he was joint-king or ruler of Argos: and Eriphyle became the mother of Alkmaion [Alcmœon]. The great event with which the name of Amphiaraos is associated is the war waged by Polyneikes (Polynices), the son of Oidipous (Œdipus), to wrest the throne of Thebes from his brother Eteokles. As Troy could not be taken without the arrows of Philoktetes, so is Amphiaraos indispensable for the downfall of Thebes. But his going thither is the result of treachery, and the cause of many woes. The necklace or girdle and the peplos or robe, of Harmonia, the wife of Kadmos (Cadmus), were always to be a fruitful source of evils, like the wealth of the Spartan Helen, and the treasures of Brynhild in the stories of the Volsungs and the Nibelungs. Amphiaraos hated the thought of mingling in the strife, just as Achilleus disliked having anything to do with a quarrel which was not of his own making. As a seer, he knew that of all the chiefs engaged in the expedition Adrastos alone would return alive. But he had promised Adrastos that in any disputes which might arise between them he would abide by the decision of his wife Eriphyle, and Eriphyle yielded to the bribe of Harmonia's necklace offered to her by Polyneikes.

Thus constrained to go, Amphiaraos charged his son Alkmaion to slay his mother so soon as he should receive tidings of his death. His forebodings were realised; but Zeus would not allow him to fall by the sword of his enemies. So the earth opened and swallowed up Amphiaraos in his chariot; and the oracle where he gave his answers to those who sought his counsel became one of the most famous in all Hellas. Eriphyle fell by the hand of her son; but the Erinyes, who exact vengeance for the shedding of blood, gave Alkmaion no peace by night or by day. Like Orestes, who requited the death of AGAMEMNON on his mother Clytemnestra, he wandered, maddened in spirit, through the land, till at last he reached the shrine of Apollo at Delphi. There the priestess bade him offer the necklace of Harmonia, and told him that he should have rest only when he could find a spot which the sun had not yet seen when he avenged his father's death. Bewildered with sorrow, he found himself at length on the shores of the Achelôos (ACHERON), where it flows lazily into the sea. There the slime, rising higher and higher each year, made

new land, which covered itself with wild tangled grass. Here, as he sank down in weariness, he heard a voice which said, 'This is thy place of rest, for here the blood which thou hast shed cannot taint the air. Here after ten years thy hands shall again be pure, and thou shalt return and lead thy kinsfolk to avenge the blood of their fathers against the men of Thebes.'

AMPHION, in Greek mythology, is, like Orpheus, Hermes, and Pan, one of the gods or heroes who are masters of the witching powers of song. The lyre or harp, which in their hands is irresistible, reappears in those of the minstrel Volker, in the story of the Nibelungs, of the piper of Hameln, of the faithful servant in the story of the Jew among the Thorns, and many more. Amphion is commonly spoken of as a son of Zeus and Antiope, and a twin-brother of Zethos. They are thus Dioskouroi (Dioscuri), or children of Zeus, as are also Kastor and Polydeukes (Castor and Pollux), and they thus take their places among the vast multitude of gods or heroes who, as being born together, or as appearing at fixed intervals each after the other, are known as CORRELATIVE DEITIES. Like most of the Dioskouroi, Amphion and Zethos are exposed immediately after their birth, and, like them, are rescued by shepherds, among whom they, with Antiope, are said to have dwelt for years. As they grow up, Zethos betakes himself to tending the flocks, while Amphion receives from HERMES a harp, which makes the stones not merely move, but fix themselves in their places as he builds the walls of Thebes. Like Romulus and Remus, like Cyrus, Œdipus, and the rest, they avenge themselves on those who have done them wrong; and their stepmother Dirkê, who had brought about the expulsion of Antiope, is tied to a bull and dragged to death, her body being then thrown into the well which bears her name. Amphion, it is said, became the husband of NIOBE, and slew himself through grief when he saw his beautiful children all smitten down by the unerring spears of Phœbus and his sister Artemis.

AMPHITRITE, in the Odyssey, is spoken of simply as the purple-faced, loud-sounding sea. Elsewhere she is an Okeanid, or nymph of the ocean, who becomes the wife of Poseidon, a god belonging originally not to Greek but to Semitic mythology, in which he is the husband of the fish-goddess Derketo, called by the Greeks Atergatis, the mother of Sammuramit (Semiramis). When his worship was introduced into Greece, he was separated from his Syrian mate and wedded to Amphitrite, the second part of whose name connects itself with Tritonis and Tritogeneia, epithets of Athênê, and with Tritos, or Triton, a lord of the waters. When we go back to the Veda, the earliest sacred books of the Hindus, we find there that Trita is the god of the water and the air; and thus all these names are explained. The Trita or Traitana of India reappears in Persia as Thraetana, the slayer of the serpent ZOHAK.

AMULIUS [ROMULUS].

AMYMONE [DANAOS and ÆGYPTOS].

ANANKE.—This word simply means necessity. In Euripides it appears as a living power, to which even the highest of the gods is compelled to submit. Ananke is thus the chief among such powers as AISA, the Fates, Erinyes, etc. The origin of the idea of this irresistible doom is plainly seen in the course of day and night, summer and winter. The sun cannot be stayed in his journey, and he must sink as he has risen. The phenomena (as we call them) of evening are much the same as those of the morning; hence, it is said that the sun must be united again with the mother from whom he was parted when the day was yet young. Hence, among many others, the marriage of Œdipus with Iokastê, and hence also all the train of woes which followed it, and which were regarded as the work of the inexorable Anankê, or Destiny. Hence, again, the more modern notions of predestination.

ANCHISES, one of the Trojan chieftains, was the father of Aineias (Æneas), the hero of the Æneid of Virgil. The so-called Homeric Hymn to Aphrodite tells the story how, in the guise of a simple maiden, the goddess came to the folds where Anchises was tending his flocks, and how Aineias was born and carefully nourished by the nymphs. Anchises, it is said, forgot his promise not to make the parentage of his son known, and Aphrodite slew him with a flash of lightning. In other versions he is only blinded, and Virgil represents Æneas as carrying his father on his back from the ruins of the burning city, and speaks of Anchises as dying in Sicily, and as being buried on Mount Eryx.

ANDROGEOS [THESEUS].

(To be continued.)

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How I Teach Domestic Economy.

BY MRS. WIGLEY,

Author of 'Marshfield Maidens,' 'Our Home Work,' 'Workers at Home,' 'Royal Series Domestic Economy,' 'Cookery and Home Comforts,' 'The Merryweathers,' 'Thoughts,' etc.

CHAPTER XIII.

EXTRACTS FOR DICTATION.

YOU will allow me to insert here some important extracts from different authorities, which you may find useful for reproduction in home lessons, or for dictation exercises. They bear directly on our subject, and explain in this way some of those matters which we are in danger of leaving unexplained:—

Bones.—'Bones are composed of lime and gelatine. If a bone is steeped in strong acid for a length of time, the earthy properties will be dissolved, and only the gelatine remain. This will keep the perfect form of the bone, but will be soft and flexible.

'Or again, if the gelatine be destroyed by heat, the lime will remain in the original shape, but will be exceedingly brittle. The one of these substances then acts as a help to the other, so making the bone both tough and hard. To prove that the bones are affected by the food we eat, a bright red dye has been mixed with the food given to animals. It was found that very soon the bones became red, and that when the dyed food was discontinued, the bones were white again.'—Dr. LE PILEUR.

The Daily Waste.—'The numberless organs and tissues of which man's body consists are undergoing perpetual change, and in carrying out its functions some part of each organ is destroyed. Thus we cannot think, feel, or move without wasting some portion of the brain, the nerves, or the muscles.

'The wasted or used-up material cannot remain in its original situation, *there* it would not only be useless but injurious. Such old material is being daily removed from our bodies to the average amount of

three or four pounds. Now, to take the place of the old material daily removed, there should be daily added at least an equal quantity of fresh material. It is by the digestion of the food we eat that we are able to add to the blood so much new solid and liquid material as will take the place of that which is used up by the organs of the body.'—Dr. FOULIS.

Mineral Food.—'Our flesh and blood contain a large quantity of minerals and salts. If we could take a man and pound him up in a mortar, and then analyse the constituents of which he was composed, what should we find? Why, we should discover that at least ten parts out of every hundred were mineral matters. We should find lime and iron, and phosphorus and sulphur, and many others. Now if these things are found in our tissues. they must be found in the blood which makes the tissues, and first of all in the food which makes the blood.

'If the food does not contain sufficient lime, then the bones and the teeth are not properly formed, and must suffer from disease. If children do not get enough lime in their food, then the bones do not become hard and firm, but remain soft, and often remain bent and of a bad shape. When you see a little child with bent legs you may know it has not had sufficient mineral food.

'But the blood contains many other mineral substances. Iron is found all through the blood. It is this which gives it its red colour. Sometimes medical men are consulted by patients who seem to have lost their strength. They are pale in the cheek and lips, instead of being ruddy and healthy; then we prescribe iron for a medicine, because we know they have not been taking enough with their food, and very often we are rewarded by seeing their colour and strength return to them. In the same way doctors often give as medicines phosphorus and soda and potash.

'Remember, that if you exclude mineral food from your diet, you will as certainly die as though you were deprived of food altogether.'—Dr. FOULIS.

Fats as Heat Producers.—'The use of fats as heat producers is well known to every one. In very cold countries, as the Arctic Regions, the inhabitants eat fat to a very large extent; indeed, it is difficult to satisfy the craving for this kind of food where the cold is intense. The daily allowance of fat to each of our sailors in one expedition was eight pounds, while the natives will readily consume twenty pounds a day.'—Dr. RUSSEL.

Need of Repair.—'Not only our internal warmth but our muscular and our nervous action depend upon the food we eat. Let a person begin his daily work before breakfast, and when dinner-time comes continue that work without taking any nourishment. Soon, whether his work consist of mental or physical labour, missing his food will begin to tell. But let him go on, and what will be the consequence? A time will soon come when the nerves or the muscles will refuse to do their duty, when movement or action becomes impossible, when the brain cannot think, and the person sinks into a state of unconsciousness. Not only the nerves but the muscular system is affected, and at last the starved man dies. We need constant repair, because we constantly wear out. Our skin rubs off, our mucous membrane wears, our internal organs disappear by degrees. And unless we keep up the supply needed for constant repair, we shall suffer by sickness and disease, if not death.'—Dr. LANKESTER.

'Now the body of the living man is always in a state of activity, even when he is asleep. Although the head and the limbs are quiet, the heaving chest shows that some parts are active. At all times, day and night, the heart is beating, driving the hot blood to all parts of the body to nourish the various tissues, and to carry away the waste matters and rubbish that are worn out. All activity means work, all work means waste. If a man weighs himself, and then engages in some violent continuous exertion for an hour or two, he will find on weighing himself again that he has diminished his weight by his exertion so many actual ounces. He has worn out so much of his body by his activity. And the harder he works the hungrier he gets, and the more heartily he eats. Nature cries out to have the waste parts made good again.'—Dr. HALDANE.

In our next paper we must consider 'The Right Balance of Various Foods.'

(*To be continued.*)

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Lessons in Latin.

BY THE REV. A. D. CAPEL, M.A., CANTAB.,
Formerly Examiner of Schools to Cambridge Local Examination Syndicate.

(*Continued from page* 536, *vol. v.*)

KEY TO EXERCISES.

EXERCISE 72.

A.

1. Let us die and rush into the midst of the arms (*i.e.*, into the middle of the fight). 2. May you return late to heaven (that is, may you live a long time). 3. From the day on which he was declared leader, thinking there ought to be no delay, lest some misfortune should oppress him, delaying, as (it had) his father Hamilcar, next Hasdrubal, he determined to wage war against the Saguntini. 4. Six thousand of the enemy were slain, two camps were taken, with their garrisons, for both the camps were stormed and the leader himself, with some princes, are taken. 5. And they prepare both to bake with flames the fruits received, and to break them with a stone. 6. Very many say that Caesar will not remain in the agreement, and (affirm) that these demands were inserted by him. 7. Scipio was made consul twice: first before the time, and secondly in his own (proper) time. 8. The Senate was held at the Temple of Apollo on the seventh day before the Kalends of October (Sept. 25th). 9. He went away; he departed; he got out; he burst forth. 10. And those who despise these, in both directions, with a lofty and great mind, and when some great and honest thing is presented to them, it turns and seizes all men to himself; then who cannot admire the splendour and beauty of virtue?

B.

1. Hannibal paucis post diebus sex millia a Placentia castra communivit. 2. Equorum pars magna nantes loris a puppibus trahebantur. 3. Magnae partis fuga inde primum coepit; et jam nec lacus nec montes pavori obstabant; per omnia arta praeruptaque velut caeci evadunt, armaque et viri super alium alii praecipitantur. 4. Tela viris animique cadunt. 5. Mox navigo Ephesum. 6. Una Eurusque, Notusque ruunt,

creberque procellis Africus. 7. Pars in crucem acti sunt, pars bestiis objecti. 8. Pateris libamus et auro. 9. Si, ut Graeci dicunt, omnes aut Graios esse aut Barbaros, vereor ne Romulus Barbarorum rex fuerit. 10. Querimoniae conventusque habebantur.

EXERCISE 73.

A.

1. I am going to write the war which the Roman people waged with Jugurtha. 2. For that god ruling over us forbids us to remove hence against his command. 3. For what is so unnatural to man as to use eloquence for the destruction of good men? 4. I pray and entreat you, my son, by whatsoever laws that join children to parents. 5. As not all fields which are cultivated are fruitful, so not all cultivated minds bear fruit. 6. Themistocles is lawfully praised, and his name is more illustrious than that of Solon. 7. Men do not understand how great a tax thrift is. 8. Not only for ourselves do we wish to be rich, but for our children, neighbours, friends. 9. When any one has once perjured himself, he ought not afterwards to be believed. 10. I thus think the Latin tongue is not only not meagre, but even richer than the Greek.

B.

1. Nihil est agricultura melius, nihil homine libero dignius. 2. Fratris tui mors acerbissima mihi fuit. 3. Sanguis a corde in totum corpus distribuitur. 4. Deum agnoscimus ex operibus ejus. 5. Epaminondas, princeps meo judicio Graeciae, fidibus cecinit. 6. Omnes viri boni ipsam aequitatem amant. 7. Plus oneris sustuli, quam ferre me posse intelligo. 8. Mors servituti turpitudinique anteponenda. 9. Non paranda nobis solum, sed fruenda etiam sapientia est. 10. Quid deceat vos, non quantum liceat vobis spectare debetis.

EXERCISE 74.

(Sallust's 'Catiline,' Chap. xi.)

But at first ambition rather than avarice was exercising the minds of men, and yet this vice was nearly a virtue. For the good and the sluggish equally desire glory, honour, command for themselves: but the former strives by a true way; because good arts are wanting to the latter, he strives with frauds and deceits. Avarice has the desire for money, which no one wise has desired; this, as if saturated with bad poisons, weakens the body and manly soul; always infinite, it is insatiable, and is not diminished by either abundance or want. But after that L. Sulla, the republic having been recovered by arms, had bad results from good beginnings, all (began) to seize plunder, one to covet a house, another fields, and to have, as victors, no moderation nor modesty—to do on their (fellow) citizens filthy and cruel deeds. Hence it happened that L. Sulla had kept his army, which he had led about in Asia, by which he had made it faithful to himself, contrary to the custom of his ancestors, too luxuriously and freely; pleasant places, sensualities easily, in idleness, had softened the fierce minds of the soldiers. There first the army of the Roman people was accustomed to love, to drink, to admire statues, painted pictures, engraven vases, to seize them publicly and privately, to spoil temples, to pollute all things sacred and profane. Therefore these soldiers, after they had obtained a victory, caused that nothing should be left to the conquered.

[This translation is intentionally very bald.]

EXAMINATION QUESTIONS.

NO. 7.

606. 1. Parse, in Exercise 74, the following words, the numbers after them referring to the lines:—Exercebat (2), propius (3), concupivit (10), minuitur (14), recepta republica (15), signa (27), and adepti sunt (31). 2. Distinguish between ille (6) and huic (7). 3. Account for the subjunctive mood in faceret (22). 4. Decline majorum (22), hi milites (30), and facinora (19).

LESSON LXXV.

SOME REMARKS ON THE CASES.

607. A subjective genitive is one that, if the phrase be turned into a sentence of which the noun on which the genitive depends is the verb, the genitive will be its subject—*e.g.*, 'Caesar's love for his country' can be turned into 'Caesar loved his country,' of which Caesar is the subject; therefore, Caesar's is a subjective genitive.

608. Similarly, an objective genitive will be the object of the noun on which it depends when changed into a verb—as, 'The fear of Caesar made them lay down their arms,' which becomes 'They feared Caesar so as, etc.,' in which Caesar is the object of the verb 'fear.'

609. Of the two genitives plural of 'ego' and 'tu'—viz., nostrum, nostri, and vestrum, vestri—some grammarians believe that nostrum and vestrum are subjective genitives, and nostri and vestri objective.

610. The genitives, moris, consuetudinis, arbitrii, juris, when they stand as complements, may be explained by reference to proprium, which, like officium, is sometimes expressed.

611. A dative of purpose is often substituted for a genitive (See A, 1).

612. The possessive genitive is used as a complement in copulative and factitive construction (See A, 3).

613. When a divisible whole is distributed, it is put into the genitive (See B, 6).

614. VOCABULARY 75.

English.	*Latin.*		*Derivatives.*
Palatium	Palatium	G. Palatii	
Foundation	fundamentum	G. -ti	
Peculiarity	proprium	G. proprii	proprietor
It repents	poenitet	P. poenituit	penitent
Party	convivium	G. convivii	convivial
To recline at table	accumbere	P. R. accubu	3rd R. accubit
To drain	exhaurire	P. R. exhaus	3rd R. exhaust
Sink (hold of a ship)	sentina	G. rentinae	
To embezzle	lucri facĕre (often written as one word)		
To matter more, To be of more importance	pluris referre	P. R. retul	3rd R. relat
Sieve	crībrum	G. cribri	
Sauciness	petulantia	G. petulantiae	
Good	prōbus -a -um	R. prob	
To take account	rātiōnem habēre	P. R. habu	3rd R. habit
Key	clāvis	G. clavis	
To take possession	suae potestatis facĕre (see Voc. 31)		
To take in good part	aequi boni facere		
To be of great importance	magni interesse		
Beast	bellua	G. belluae	
Adversity	res adversae, used in plural.		
History	historia	G. historiae	
To dare	audere	3rd R. aus (Passive orm used in perfect tenses).	

615. EXERCISE 75.

A.

1. In (16) Palatio prima (47) urbi (7) fundamenta jeci (49). 2. Omnia (29) quae (27) mulieris (28) fuerunt (38) viri (18) fiunt (56) dotis (41) nomine (20). 3. Honoris (49) amplissimi (72) esse (38) puto (49)

miseros (28) defendere (42). 4. Sapientis (49) est proprium, nihil (31) quod (27) poenitere possit (50) facere (43). 5. Negavit (53) moris (56) esse (38) Graecorum (44) ut in convivio virorum (18) accumberent mulieres (28). 6. Exhaurietur ex (67) urbe (7) tuorum (20) comitum (48) magna (20) et perniciosa (49) sentina republicae (45). 7. A (67) Verre omnem (29) illam (37) pecuniam (45) lucri factam videtis (27). 8. Hic non pluris refert quam (48) si (15) imbrem (39) in cribrum geras (43). 9. Neque (54) stultorum (61) quisquam (70) beatus (38) neque (54) sapientium (49) non beatus. 10. Petulantia magis (45) est adolescentium (41) quam (48) senum (46); nec (54) tamen (20) omnium (29) adolescentium, sed (6) non proborum.

B.

1. A man should take account not of himself (20) alone, but also (45) of others (31). 2. You (35) are (38) his (37) father (14) by nature (46), I (35) by counsels (40). 3. Popillius took possession of the keys of the gates (13). 4. My (20) mind (45) takes all (31) that (40) in good part. 5. It is of great importance to both (31) of us (35) that (6) I see (27) you (35). 6. Of beasts, none (31) is more sagacious (prudent, 49) than the elephant (35). 7. To man (5) alone ('unus,' 31) of animals ('animans') sorrow (59) has been given (62). 8. I remember (46) the living (56), nor (48) yet (20) may (48) I forget (46) Epicurus. 9. Adversity advises (30) us (35) of religious-duties (69). 10. The first (47) law (5) of history is that it should not dare to say (62) anything (70) false (63); nothing true (29) be afraid [say, 'not to dare'] (to say) —*i.e.*, nor be afraid to say anything true.

LESSON LXXVI.

EXTRACT FROM OVID'S HEROIDES.

616. VOCABULARY 76.

English.	*Latin.*		*Derivatives.*
Contented	contentus -ta -tum	R. content	
Priam, son of	Priamides (see Notes to Ex.)		
Nymph (sea goddess), Bride	nympha	G. nymphae	
Covert, Grove	saltus	G. saltūs	
Hunting	vēnātus	G. venātūs	
Fit	aptus -ta -tum	R. apt	
Net	rete	G. retis, n.g.	reticulate
Mesh	macula	G. maculae (see Voc. 50)	
Wide	distinctus -ta-tum	R. distinct	
To stretch	tĕndĕre	P. R. tetend	3rd R. tent
Swift	citus -ta -tum	R. cit	
Ridge	jugum	G. jugi, n.g.	
Beech-tree	fāgus	G. fagi, f.g.	
To mark	notāre	R. not	notation
Trunk	truncus	G. trunci	truncate
To grow	crescĕre	P. R. crēv	cĭēt
Poplar-tree	pōpulus	G. populi, f.g.	
Right, Straight	rectus -ta -tum	R. rect	erect
To sow	consĕrĕre	P. R. consēv	consit
Edge	margo	G. marginis, m.g.	margin
Bank	rīpa	G. ripae	
Rough	rūgōsus -sa -sum	R. rugos	
Bark	cortex	G. corticis	decorticated
To breathe	spīrāre	R. spir	expire
To run back	recurrĕre	P. R. recurri	No 3rd R.
Back	rĕtro, adv.		retrospect
To hasten	prōpĕrāre	R. proper	
Water	lympha	G. lymphae	
Fate	fātūm	G. fāti	fatal
To change	mutāre	R. mut	immutable
Decent	dĕcens	G. decentis	
Naked	nūdus -da -dum	R. nud	nude

EXERCISE 76.

617. Translate the following extract from Ovid's Heroides. It is a portion of a letter supposed to be written by Oenone to Paris. The argument is as follows:—Oenone, once loved, but now deserted by Paris, reminds him of their former happy companionship, when he was a shepherd on Mount Ida, and she, though a nymph, did not disdain his love. Then it was she who helped him in the hunt; then he swore to her eternal fidelity, and cut the words of his vow on a poplar tree.

(*For Notes, see end of extract.*)

Nondum (42) tantus (40) eras (38), quum (13) te (35) contenta marito (9)
edita (30) de (67) magno (20) flumine nympha fui (38).
Qui (27) nunc Priamides. . . . absit (50) reverentia (67) vero (5) . . .
servus (7) eras (38). Servo nubere (57) nympha tuli (53).
Quis (30) tibi (35) monstrabat (13) saltus venatibus aptos,
et tegeret (58) catulos (14) qua (27) fera (50) rupe (37) suos (20)?
Retia saepe (35) comes (48) maculis distincta tetendi:
saepe (35) citos egi (50) per (67) juga longa (49) canes (14):
Incisae (50) servant (10) a te (35) mea (20) nomina (20) fagi,
et legor (6) Oenone falce (16) notata tua (20):
et quantum (54) trunci, tantum (54) mea (20) nomina (20) crescunt:
crescite, et in titulos (see note) surgite (39) recta meos (20).
Populе, vive (48), precor (73), quae (27) consita margine ripae
hoc (37) in rugoso cortice carmen (9) habes (7).
'Quum (13) Paris Oenone poterit (50) spirare relicta' (26),
ad (67) fontem (12) Xanthi versa (55) recurret aqua (7).
Xanthe, retro propera, versaeque (55) recurrite lymphae!
sustinet (see note) Oenonen deseruisse (66) Paris.
Illa (37) dies (8) fatum miserae (28) mihi (35) dixit (62), ab (67) illa (37)
pessima (49) mutati coepit (37) amoris (49) hiems (16),
quâ (27) Venus et Juno, sumptisque (63) decentur armis (36)
venit (19) in arbitrium (54) nuda Minerva tuum (20).

Notes on the above.

Line 2. 'Nympha' properly means 'bride,' but in the plural it generally means the demi-goddesses who inhabited rivers. Oenone here calls herself a nymph because she was the daughter of the River Kebren.

Line 3. 'Priamides' means son of Priam.

It is a Latinised Greek word. These words ending in '-ides' are called patronymics. In Russia every man bears such a name in addition to his own, the termination '-ides' in Greek being 'vitch' in modern Russian—as Alexandrovitch, the son of Alexander. These Latin patronymics are thus declined:—N. -des, V. -de or -da, Ac. -den, G. -dae, D. -dae, Ab. -de.

Ib. 'Absit reverentia vero' means that everything must give way to truth.

Line 10. 'Oenone' is declined very like 'Priamides' but keeping the Greek gen., thus:—N. V. Oenone, Ac. Oenonen, G. Oenones, D. Oenonae (if found), Ab. Oenone.

Line 12. 'Titulus,' which means a superscription, may here mean an epitaph, and the line may be thus translated—'Grow on, ye names, and rise aright to form my epitaph.'

Line 16. Xanthus, a river of Troas.

Line 19. 'Illa dies,' viz., that on which Venus, Juno, and Minerva came to Paris to have a dispute decided. He gave his judgment to Venus, for which she promised him Helen: hence the Trojan war.

B.

(*The numbers refer to the lines of the extract.*)

1. Parse 'edita' (2). 2. Parse 'absit' (3). 3. What case is 'servo,' (4), and why? 4. Parse 'saltus' (5). 5. Parse 'tegeret' (6), and state why in subjunctive mood. 6. Parse 'comes' (7). 7. What can you argue from the form of such perfects as 'tetendi' (7). 8. Give principal

parts of 'egi' (8). 9. Decline, in the plural, 'canes.' 10. Of what gender are trees, and what reason could you give for their being exceptionally so? 11. What does 'recta' (12) agree with? 12. Write out the tenses 'poterit' (15) and 'recurret' (16). 13. Parse 'propera' (17) and 'recurrite' (17). 14. How do you know that 'venit' (22) is perfect and not present. 15. Of what metre are these couplets? 16. Scan lines 11—14.

(To be continued.)

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Chemistry of the Non-Metallics.

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CHAPTER XVII.

IODINE ἰωδης (iodes) = violet. PREPARATION. PROPERTIES. HYDROGEN IODIDE.

A. 1.
B. 127.
C. PREPARATION.—From kelp.

(1) Kelp is the ashes of sea-weeds, and contains iodides of potassium and other metals. Iodides acted on by manganese dioxide and sulphuric acid in a retort yield manganese sulphate, a sulphate of the metal combined with the iodine, hydrogen oxide, and iodine.

(2) $2KI + MnO^2 + 2H_2SO^4 = K^2SO^4 + MnSO^4 + 2H^2O + I^2$.
(3) 332 + 87 + 196 = 174 + 151 + 36 + 254.

D. (1) Solid: crystalline, rhomboidal, melts at 107°, boils at 175°.

(2) Curious odour; lustre like that of graphite: the vapour is violet.

(3) As a solid 4·95. As a gas 127, or $\frac{127}{14{\cdot}47}$. The heaviest gas known.

(4) 100 cc. of water dissolve $\frac{1}{7\frac{1}{2}}$ cc. of iodine. Soluble in alcohol, and in a solution of potassium iodide. The former solution is the liniment or tincture used in medicine for outward application. The latter solution is Sugol's, used as an internal remedy. A pretty experiment is afforded by placing in distilled water a piece of iodine, and then dropping in a piece of potassium iodide. As the latter dissolves the iodine is also dissolved, and the shaking of the test tube produces suddenly a beautiful purple solution.

(5) Not combustible.
(6) With starch it gives a blue colour.

In medicine it is used as a tonic, and to produce absorption of glandular swellings.

E. Hydrogen iodide.
(*a*) HI.
(*b*) 128.
(*c*) From sulphuretted hydrogen, iodine, and water, or from iodine, phosphorus, and water.

The methods and the reactions are similar to those in the preparation of hydrogen bromide.

$5I_2 + 4H^2O + 2H^2S = H^2SO^4 + 10HI + S$
1270 + 72 + 68 = 98 + 1280 + 32
20 vols.

$2P + 8H^2O + 5I_2 = 2H_3PO^4 + 10HI$
62 + 144 + 1270 = 196 + 1280
20 vols.

A. (1) Gas, liquefies at —, solidifying at — 51°.
(2) Irritating, colourless.
(3) 64, or $\frac{64}{14{\cdot}47}$.
(4) Very soluble. Fumes in air.
(5) Not combustible, and does not support combustion.
(6) Acid.

By replacement of the hydrogen in hydrogen iodide metallic iodides are formed.

HI	...	...	...	Hydrogen iodide.
NaI	...	...	...	Sodium ,,
PbI_2	...	...	...	Lead ,,

Tests for Iodides.

(1) $+BaCl^2$ = no precipitate.
$2KI\ (e.g.) + BaCl^2 = 2KCl + BaI_2$
332 + 208 = 149 + 391.

(2) $+AgNO_3$ = yellow precipitate, insoluble in ammonia.
$KI\ (e.g.) + AgNO^3 = KNO^3 + AgI$
166 + 170 = 101 + 235.

(3) $+Pb2NO^3$ = yellow precipitate.
$2KI\ (e.g.) + Pb2NO^3 = KNO_3 + PbI_2$
332 + 331 = 202 + 461.

QUESTIONS ON IODINE. (*Solved.*)

105. What is the pressure of iodine vapour at a temperature of 273°, and a density of $66\frac{6}{19}$?

At temperature of 0°, density = 127.

The volume of a gas is inversely as its density. When the volume increases, the density diminishes.

273 vols. at 0° become at 273°, 546 vols.
1 vol. ,, becomes ,, $\frac{546}{273} = 2$.

∴ density of iodine vapour at 273, and under normal pressure, is $\frac{127}{2}$.

The density is $\frac{127}{2}$ under pressure 760.

1 ,, $\frac{760 \times 2}{127}$

$66\frac{6}{19}$,, $\frac{760 \times 2 \times 1270}{127 \times 19} = 800$ mm.

106. What is the pressure, if at normal temperature the density of hydrogen iodide is 64?

The density of HI is 128 under 760 mm. pressure.

1 ,, $\frac{760}{128}$,,

64 ,, $\frac{760 \times 64}{128} = 380$ mm.

QUESTIONS ON IODINE. (*For Solution.*)

109*a*. Under what pressure is the density of iodine vapour at a temperature of 130°, $86\frac{1}{3}$? ... ... Normal pressure.

110. What is the temperature if, when the pressure on hydrogen iodide gas is double the atmospheric pressure, its density is 96? ... ... 91°.

CHAPTER XVIII.

FLUORINE, A CONSTITUENT OF FLUOR-SPAR, HYDROGEN FLUORIDE.

A. F.
B. 19.
C. Not satisfactorily isolated as yet. Fluorine occurs in combination with calcium in fluor-spar, calcium fluoride (CaF_2). It is also present, combined with certain metals, in bones and teeth.
D.
E. F. HYDROGEN FLUORIDE.
(*a*) H_2F.
(*b*) 20.
(*c*) From calcium fluoride and sulphuric acid.

(1) Place in a leaden inkpot powdered fluor-spar. Prepare a piece of plate glass covered with wax, part of which has been removed by aid of some sharp instrument, so as to leave the glass exposed in certain places. Pour on the fluor-spar three or four times its volume of strongest sulphuric acid. Heat very gently. Calcium sulphate is formed, and hydrogen fluoride is given off. This gas eats into the glass where it is not covered by the wax.

(2) $CaF^2 + H^2SO^4 = CaSO^4 + 2HF$
78 + 98 = 136 + 40
4 vols.

(*d*) (1) Liquid, boiling at 19·4°.
(2) Irritating, colourless.
(3) ·9879 as a liquid, 10 or $\frac{10}{14{\cdot}47}$ as a gas.
(4) Very soluble, fumes strongly.
(5) Not combustible.
(6) Used for etching on glass.

Glass consists largely of silicates of certain metals.

Hydrogen fluoride acts on silicon dioxide, forming hydrogen oxide and silicon fluoride.

$$SiO^2+4HF=2H^2O+SiF^4$$
$$60 + 80 = 36 + 104.$$

QUESTION ON FLUORINE. (*Solved.*)

107. Find the weight of fluor-spar that will be decomposed by 49 grams of sulphuric acid.

98 grams H^2SO^4 decompose 78 grams CaF^2

1 gram ,, decomposes $\frac{78}{98}$,,

49 grams ,, decompose $\frac{78\times49}{98}=39$ grams.

QUESTION ON FLUORINE. (*For Solution.*)

111. After the action of sulphuric acid on fluor-spar, 39 grams of calcium sulphate are left. What volume of hydrogen fluoride has been given off? ... ... 11·2 litres.

CHAPTER XIX.

SULPHUR: PREPARATION, FORMS, PROPERTIES.

A. S.

B. 32.

C. Sulphur is found in volcanic districts. Most of the European sulphur comes from Sicily. The sulphur is mixed with much earthy matter. Where the ore is rich in sulphur it is melted in iron pots, and the sulphur is ladled out and thrown into cold water. Where the quantity of sulphur is small, the ore is distilled in earthenware pots, and the sulphur that comes off, long before any of the other constituents of the ore evaporate, is condensed in other pots of the same material. From these it flows into cold water, where it solidifies as rough sulphur.

To purify the rough sulphur it is melted in an iron pot, run off thence to a retort of the same metal, and there boiled. No air is allowed to enter the apparatus or the sulphur would combine with the oxygen of the air. The vapour of sulphur is carried into a large room, whose walls are of rough bricks. On the walls the vapour condenses in microscopic crystals, as flowers of sulphur. If the temperature of the room is allowed to rise to a higher degree, the sulphur melts again, and flowing down the walls is drawn off into wooden moulds, to form roll sulphur or brimstone.

D. (1) Solid, melting at 115°-120°, boiling at 440°. Dimorphic and allotropic. Its forms will now be considered.

(*a*) Native sulphur is in the form of large octahedral crystals.

(*b*) Roll sulphur is apparently amorphous, but really it is at first a mass of one kind of crystals, that later change into crystals of another shape. The first crystals are prismatic, the second octahedral.

(*c*) Flowers of sulphur are apparently amorphous. Really they are a mass of minute octahedral crystals.

(*d*) Melt sulphur in a crucible. When a crust has formed, pierce it at two places, and pour out through one of the openings the liquid portions. The shell of solid sulphur is lined internally with prismatic crystals. This form if scratched, breaks up into minute octahedral crystals.

(*e*) Sulphur crystallised out from its solution in carbon disulphide (CS^2) is in the octahedral form.

(*f*) Melt sulphur, and when the temperature is about 280° pour it into cold water. The plastic modification of sulphur is formed.

(2) Slight, characteristic odour: yellow, opaque.

(3) Octahedral, 2·05; prismatic, 1·98; plastic, 1·95.

Its vapour density is abnormal, and breaks the law of volumes. Below 1,000°, instead of its density being 32 times that of hydrogen at the same temperature, it is 96. Hence sulphur is often spoken of as a three-volume vapour. At 1,000° this abnormality disappears, and sulphur is 32 times as heavy as hydrogen at the same temperature.

(4) Not soluble in water. Soluble in carbon disulphide, unless the sulphur is in the plastic form. That form is not soluble in carbon disulphide.

(5) Combustible, forming sulphur dioxide.

$$S+O^2=SO^2$$
$$32+32=64$$
2 vols. 2 vols.

(6) The effect of heat on sulphur is very remarkable. The sulphur melts at 115°, and is a limpid, orange-coloured liquid. At 120° it becomes less limpid, and darker in colour. At 200°-225° it is viscid, nearly black. Above 250° it becomes limpid again, but never so limpid as at 115°. At 440° it goes off as an orange-coloured gas.

A bad conducter of heat and electricity. The former characteristic is the cause of its crackling when held in the warm hand. Heated with carbon it unites with that element to form carbon disulphide.

$$C+S^2=CS^2$$
$$12+64=76$$
2 vols.

Copper filings heated gently in the vapour of sulphur, combine with it and form copper sulphide.

$$2Cu+S_2=2CuS$$
$$126+64=190.$$

EXAMPLES ON SULPHUR. (*Solved.*)

108. What volume of sulphur dioxide results from the burning of 8 grams of sulphur in 4 grams of oxygen? The pressure is normal, the temperature 520°.

32 grams of S need for combustion 32 grams O

1 gram ,, needs ,, $\frac{32}{32}$,,

8 grams ,, need ,, $\frac{32\times8}{32}$,, $=8$.

But there are only 4 grams oxygen, and therefore the calculation should be based on these.

32 grams O combining with S form 22·4 litres SO^2.

1 gram ,, forms $\frac{22\cdot4}{32}$,,

4 grams ,, form $\frac{22\cdot4\times4}{32}$,,

273 vols. at 0° become at 520°, 793

1 vol. ,, becomes ,, $\frac{793}{273}$

$\frac{22\cdot4\times4}{32}$,, become ,, $\frac{793\times22\cdot4\times4}{273\times32}=8\frac{4}{10}$ litres.

4 grams of the sulphur are not affected.

109. What weights of what bodies result from the heating together of 20 grams of carbon and 20 of sulphur?

64 grams S unite with 12 grams C, forming 76 grams CS^2.

1 gram ,, unites ,, $\frac{12}{64}$,, ,, $\frac{76}{64}$,,

20 grams ,, unite ,, $\frac{12\times20}{64}$,, ,, $\frac{76\times20}{64}$,,

$\therefore$ 20 − $3\frac{3}{4}$ S = $16\frac{1}{4}$ grams carbon, and $20\frac{3}{4}$ grams CS^2 result.

110. What is the volume of 48 grams of sulphur at a temperature of 507°?

96 grams S at 0° × 760 mm. occupy 11·2 litres.

1 gram ,, ,, occupies $\frac{11\cdot2}{96}$,,

48 grams ,, ,, occupy $\frac{11\cdot2\times48}{96}$,,

273 vols. at 0° become 780 at 507°

1 vol. ,, becomes $\frac{780}{273}$,,

$\frac{11\cdot2\times48}{96}$,, become $\frac{780\times11\cdot2\times48}{273\times96}=16$ litres.

QUESTIONS ON SULPHUR. (*For Solution.*)

112. What weight of sulphur dioxide is formed by the burning of 16 grams of sulphur in a quantity of oxygen that would occupy at normal temperature and pressure, 5·6 litres? 16 grams.

113. 40 grams of carbon are heated with 192 grams of sulphur. What weight of what bodies result? 4 grams C, 228 grams CS^2

114. Find the volume of 192 grams of sulphur at 507°, pressure 780 mm. .... $62\frac{1}{2}$ lit.

115. At what temperature will 96 grams of sulphur occupy 22·4 litres? ..... 273°.

(*To be continued.*)

parts of 'egi' (8). 9. Decline, in the plural, 'canes.' 10. Of what gender are trees, and what reason could you give for their being exceptionally so? 11. What does 'recta' (12) agree with? 12. Write out the tenses 'poterit' (15) and 'recurret' (16). 13. Parse 'propera' (17) and 'recurrite' (17). 14. How do you know that 'venit' (22) is perfect and not present. 15. Of what metre are these couplets? 16. Scan lines 11—14.

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$$1270 + 72 + 68 = 98 + 1280 + 32$$
20 vols.

$$2P + 8H^2O + 5I_2 = 2H_3PO^4 + 10HI$$
$$62 + 144 + 1270 = 196 + 1280$$
20 vols.

A. (1) Gas, liquefies at —, solidifying at — 51°.

(2) Irritating, colourless.

(3) 64, or $\frac{64}{14{\cdot}47}$.

(4) Very soluble. Fumes in air.

(5) Not combustible, and does not support combustion.

(6) Acid.

By replacement of the hydrogen in hydrogen iodide metallic iodides are formed.

HI	...	...	...	Hydrogen iodide.
NaI	...	...	...	Sodium ,,
PbI_2	...	...	...	Lead ,,

Tests for Iodides.

(1) $+BaCl^2$ = no precipitate.
$2KI$ (*e.g.*) $+ BaCl^2 = 2KCl + BaI_2$
332 +208 =149 +391.

(2) $+AgNO_3$ = yellow precipitate, insoluble in ammonia.
KI (*e.g.*) $+ AgNO^3 = KNO^3 + AgI$
166 + 170 =101 +235.

(3) $+Pb2NO^3$ = yellow precipitate.
$2KI$ (*e.g.*) $+ Pb2NO^3 = KNO_3 + PbI_2$
332 + 331 =202 +461.

QUESTIONS ON IODINE. (*Solved.*)

105. What is the pressure of iodine vapour at a temperature of 273°, and a density of $66\frac{6}{19}$?

At temperature of 0°, density = 127.

The volume of a gas is inversely as its density. When the volume increases, the density diminishes.

273 vols. at 0° become at 273°, 546 vols.
1 vol. ,, becomes ,, $\frac{546}{273} = 2$.

∴ density of iodine vapour at 273, and under normal pressure, is $1\frac{3}{4}\frac{7}{9}$.

The density is $1\frac{3}{4}\frac{7}{9}$ under pressure 760.

1 ,, $\frac{760 \times 2}{127}$

$66\frac{6}{19}$,, $\frac{760 \times 2 \times 1270}{127 \times 19} = \underline{800 \text{ mm.}}$

106. What is the pressure, if at normal temperature the density of hydrogen iodide is 64?

The density of HI is 128 under 760 mm. pressure.

1 ,, $\frac{760}{128}$,,

64 ,, $\frac{760 \times 64}{128} = \underline{380 \text{ mm.}}$

QUESTIONS ON IODINE. (*For Solution.*)

109*a*. Under what pressure is the density of iodine vapour at a temperature of 130°, $86\frac{1}{1}$? ... ... Normal pressure.

110. What is the temperature if, when the pressure on hydrogen iodide gas is double the atmospheric pressure, its density is 96? ... ... 91°.

CHAPTER XVIII.

FLUORINE, A CONSTITUENT OF FLUOR-SPAR, HYDROGEN FLUORIDE.

A. F.

B. 19.

C. Not satisfactorily isolated as yet. Fluorine occurs in combination with calcium in fluor-spar, calcium fluoride (CaF_2). It is also present, combined with certain metals, in bones and teeth.

D.

E. F. HYDROGEN FLUORIDE.

(*a*) H_2F.

(*b*) 20.

(*c*) From calcium fluoride and sulphuric acid.

(1) Place in a leaden inkpot powdered fluor-spar. Prepare a piece of plate glass covered with wax, part of which has been removed by aid of some sharp instrument, so as to leave the glass exposed in certain places. Pour on the fluor-spar three or four times its volume of strongest sulphuric acid. Heat very gently. Calcium sulphate is formed, and hydrogen fluoride is given off. This gas eats into the glass where it is not covered by the wax.

(2) $CaF^2 + H^2SO^4 = CaSO^4 + 2HF$
78 + 98 = 136 + 40
4 vols.

(*d*) (1) Liquid, boiling at 19·4°.

(2) Irritating, colourless.

(3) ·9879 as a liquid, 10 or $\frac{10}{14{\cdot}47}$ as a gas.

(4) Very soluble, fumes strongly.

(5) Not combustible.

(6) Used for etching on glass.

Glass consists largely of silicates of certain metals.

Hydrogen fluoride acts on silicon dioxide, forming hydrogen oxide and silicon fluoride.

$$SiO^2 + 4HF = 2H^2O + SiF^4$$
$$60 + 80 = 36 + 104.$$

QUESTION ON FLUORINE. (*Solved.*)

107. Find the weight of fluor-spar that will be decomposed by 49 grams of sulphuric acid.

98 grams H^2SO^4 decompose 78 grams CaF^2
1 gram " decomposes $\frac{78}{98}$ "
49 grams " decompose $\frac{78 \times 49}{98} = 39$ grams.

QUESTION ON FLUORINE. (*For Solution.*)

111. After the action of sulphuric acid on fluor-spar, 39 grams of calcium sulphate are left. What volume of hydrogen fluoride has been given off? ... ... 11·2 litres.

CHAPTER XIX.

SULPHUR: PREPARATION, FORMS, PROPERTIES.

A. S.

B. 32.

C. Sulphur is found in volcanic districts. Most of the European sulphur comes from Sicily. The sulphur is mixed with much earthy matter. Where the ore is rich in sulphur it is melted in iron pots, and the sulphur is ladled out and thrown into cold water. Where the quantity of sulphur is small, the ore is distilled in earthenware pots, and the sulphur that comes off, long before any of the other constituents of the ore evaporate, is condensed in other pots of the same material. From these it flows into cold water, where it solidifies as rough sulphur.

To purify the rough sulphur it is melted in an iron pot, run off thence to a retort of the same metal, and there boiled. No air is allowed to enter the apparatus or the sulphur would combine with the oxygen of the air. The vapour of sulphur is carried into a large room, whose walls are of rough bricks. On the walls the vapour condenses in microscopic crystals, as flowers of sulphur. If the temperature of the room is allowed to rise to a higher degree, the sulphur melts again, and flowing down the walls is drawn off into wooden moulds, to form roll sulphur or brimstone.

D. (1) Solid, melting at 115°-120°, boiling at 440°. Dimorphic and allotropic. Its forms will now be considered.

(*a*) Native sulphur is in the form of large octahedral crystals.

(*b*) Roll sulphur is apparently amorphous, but really it is at first a mass of one kind of crystals, that later change into crystals of another shape. The first crystals are prismatic, the second octahedral.

(*c*) Flowers of sulphur are apparently amorphous. Really they are a mass of minute octahedral crystals.

(*d*) Melt sulphur in a crucible. When a crust has formed, pierce it at two places, and pour out through one of the openings the liquid portions. The shell of solid sulphur is lined internally with prismatic crystals. This form if scratched, breaks up into minute octahedral crystals.

(*e*) Sulphur crystallised out from its solution in carbon disulphide (CS^2) is in the octahedral form.

(*f*) Melt sulphur, and when the temperature is about 280° pour it into cold water. The plastic modification of sulphur is formed.

(2) Slight, characteristic odour: yellow, opaque.

(3) Octahedral, 2·05; prismatic, 1·98; plastic, 1·95.

Its vapour density is abnormal, and breaks the law of volumes. Below 1,000°, instead of its density being 32 times that of hydrogen at the same temperature, it is 96. Hence sulphur is often spoken of as a three-volume vapour. At 1,000° this abnormality disappears, and sulphur is 32 times as heavy as hydrogen at the same temperature.

(4) Not soluble in water. Soluble in carbon disulphide, unless the sulphur is in the plastic form. That form is not soluble in carbon disulphide.

(5) Combustible, forming sulphur dioxide.

$$S + O^2 = SO^2$$
$$32 + 32 = 64$$
2 vols. 2 vols.

(6) The effect of heat on sulphur is very remarkable. The sulphur melts at 115°, and is a limpid, orange-coloured liquid. At 120° it becomes less limpid, and darker in colour. At 200°-225° it is viscid, nearly black. Above 250° it becomes limpid again, but never so limpid as at 115°. At 440° it goes off as an orange-coloured gas.

A bad conducter of heat and electricity. The former characteristic is the cause of its crackling when held in the warm hand. Heated with carbon it unites with that element to form carbon disulphide.

$$C + S^2 = CS^2$$
$$12 + 64 = 76$$
2 vols.

Copper filings heated gently in the vapour of sulphur, combine with it and form copper sulphide.

$$2Cu + S_2 = 2CuS$$
$$126 + 64 = 190.$$

EXAMPLES ON SULPHUR. (*Solved.*)

108. What volume of sulphur dioxide results from the burning of 8 grams of sulphur in 4 grams of oxygen? The pressure is normal, the temperature 520°.

32 grams of S need for combustion 32 grams O
1 gram " needs " $\frac{32}{32}$ "
8 grams " need " $\frac{32 \times 8}{32}$ " = 8.

But there are only 4 grams oxygen, and therefore the calculation should be based on these.

32 grams O combining with S form 22·4 litres SO^2.
1 gram " forms $\frac{22{\cdot}4}{32}$ "
4 grams " form $\frac{22{\cdot}4 \times 4}{32}$ "

273 vols. at 0° become at 520°, 793
1 vol. " becomes " $\frac{793}{273}$
$\frac{22{\cdot}4 \times 4}{32}$ " become " $\frac{793 \times 22{\cdot}4 \times 4}{273 \times 32} = 8\frac{4}{7}$ litres.

4 grams of the sulphur are not affected.

109. What weights of what bodies result from the heating together of 20 grams of carbon and 20 of sulphur?

64 grams S unite with 12 grams C, forming 76 grams CS^2.
1 gram " unites " $\frac{12}{64}$ " " $\frac{76}{64}$ "
20 grams " unite " $\frac{12 \times 20}{64}$ " " $\frac{76 \times 20}{64}$ "

$\therefore$ 20 − 3¾ S = 16¼ grams carbon, and 20¾ grams CS^2 result.

110. What is the volume of 48 grams of sulphur at a temperature of 507°?

96 grams S at 0° × 760 mm. occupy 11·2 litres.
1 gram " " occupies $\frac{11{\cdot}2}{96}$ "
48 grams " " occupy $\frac{11{\cdot}2 \times 48}{96}$ "

273 vols. at 0° become 780 at 507°
1 vol. " becomes $\frac{780}{273}$ "
$\frac{11{\cdot}2 \times 48}{96}$ " become $\frac{780 \times 11{\cdot}2 \times 48}{273 \times 96} = 16$ litres.

QUESTIONS ON SULPHUR. (*For Solution.*)

112. What weight of sulphur dioxide is formed by the burning of 16 grams of sulphur in a quantity of oxygen that would occupy at normal temperature and pressure, 5·6 litres? 16 grams.

113. 40 grams of carbon are heated with 192 grams of sulphur. What weight of what bodies result? 4 grams C, 228 grams CS^2

114. Find the volume of 192 grams of sulphur at 507°, pressure 780 mm. ..... 62½ lit.

115. At what temperature will 96 grams of sulphur occupy 22·4 litres? ..... 273°.

(*To be continued.*)

Animal Physiology.

BY ARTHUR NEWSHOLME, M.D., AND C.S.S. (LOND.)

THE DUCTLESS GLANDS.

IN articles which have appeared in previous numbers of THE PRACTICAL TEACHER, we have discussed various subjects bearing on Animal, and more particularly Human, Physiology.

Man's food has been traced in its course through the alimentary canal; the changes undergone, in order that it may be assimilated, have been explained; and the processes of absorption and assimilation into the blood have been described.

In the next place, the blood thus replenished was examined; its composition, uses, changes, and variations were detailed; and the mechanism of its circulation occupied our attention.

Having ascertained how the blood is made and what work it accomplishes, we might, in the next place, consider how its impurities—the effete products of its activity and of the activity of the tissues—are got rid of. It will be convenient, however, to consider first the ductless glands, which have an important modifying influence on the blood, and then to enter a little more fully into the mysteries of nutrition—in the course of which effete products are formed—before detailing the methods of riddance of these effete products.

Ductless Glands. In the present chapter we are concerned with the *ductless glands*, which have obscure functions, but in some way or other modify the composition of the blood.

The chief ductless glands are:—

1. The lymphatic and other lymphoid glands.
2. The spleen.
3. The thyroid gland.
4. The suprarenal bodies.

Some other smaller glands, as the coccygeal and pituitary bodies, need not be described in detail.

The lymphatic glands have been already described, as have also the solitary and agminated glands of the intestine, which are identical in structure with lymphatic glands.

The Tonsils. The tonsils and the thymus gland come under the same category. The *tonsils* are situated on each side of the back of the mouth, between the two pillars of the fauces, and nearly concealed by these, unless enlarged by inflammation or hypertrophy. They consist of masses of lymph follicles and diffuse adenoid (connective) tissue. The free surface is covered with the same kind of stratified epithelium as lines the cavity of the mouth.

When the tonsils are chronically enlarged, the speech becomes thick and indistinct, and possesses a nasal twang. The general health also suffers in consequence, and, owing largely to the diminished quantity of air entering the lungs, pallor and anæmia may result.

Thymus Gland. The *thymus* gland lies behind the sternum. Before birth it is a large and important organ, concealing the lungs; after birth it undergoes gradual degeneration. Its largest size is attained about the age of two years; in the adult it can hardly be discovered. It consists, like the tonsils, but with minor modifications, of lymphoid tissue, enclosed in a network of adenoid tissue. In the follicles are contained many-nucleated protoplasmic cells, known as the concentric bodies of Hassall.

The *thymus* gland seems to be concerned in the elaboration of blood in the fœtus. Its functions probably end as life advances; but in hibernating animals it is persistent throughout life, and as the hibernating season approaches, it becomes enlarged and loaded with fat, which serves as a store of calorific material.

The Spleen. The *spleen* is situated under cover of the ribs on the left side of the body, in contact with the under surface of the diaphragm and with the cardiac end of the stomach.

It is enveloped by serous membrane, part of the general peritoneum of the abdominal cavity. Within this is the proper capsule of the gland, consisting of white and yellow connective tissue, in the midst of which are bundles of unstriped muscular fibres.

The capsule is prolonged into the substance of the gland by trabeculæ of the same materials, which branch and anastomose, and form a retiform framework in which the tissue of the spleen is contained.

The parenchyma of the spleen, or pulp, consists of a delicate spongy network of branched cells, the spaces between which contain lymph corpuscles, probably derived by division from the branched cells of the network. The spaces are not filled up by the lymph corpuscles, but sufficient room is left to allow blood corpuscles to pass.

The artery which brings blood to the spleen is very large in proportion to the size of the organ. The smaller branches of the artery in the substance of the spleen present minute prominences on their exterior, consisting of lymphoid tissue. These are known as *Malpighian corpuscles*; they average $\frac{1}{75}$ inch in diameter, and may completely encircle the vessel, or only partially. The minute arteries open directly into the spaces of the pulp matrix, except in the case of those which supply the Malpighian corpuscles; these form capillaries, which in their turn open into the pulp spaces. The spaces of the honeycombed pulp are in communication at the other end with venous spaces or sinuses, lined with endothelial cells. The venous sinuses join together, and form the radicles of the veins, which unite and form trunk veins leaving the spleen. Here, then, is an example of an organ in which the flow of blood from arteries to veins occurs to a large extent without the intervention of capillaries. The only other instances in the body are in the placenta and the corpora cavernosa.

Functions of Spleen. The preceding study of the structure of the spleen lends considerable help in understanding its true functions. It is evident that a most striking feature of the spleen is that the blood has to pass through the spaces of the adenoid tissue, which already contain numerous lymph corpuscles. The additional anatomical fact, that the blood does not pass through closed capillaries, but along irregular and circuitous spaces, leads to much delay, and a consequently more intimate contact between the blood and the spleen pulp. Two results follow:—

(1) The blood leaving the spleen contains a much larger proportion of white corpuscles than that entering it. In certain diseases characterised by anæmia and excess of white corpuscles in the blood, the spleen is greatly enlarged, illustrating in another way the influence of the spleen on the formation of white corpuscles.

(2) There is reason for believing that many red corpuscles are broken up in the spleen. The large cells of the spleen-pulp apparently take up red blood-corpuscles, there being found in them blood-pigment, leucine, granules, and other products of the destruction of red corpuscles. At the same time, it is not improbable that coloured as well as colourless blood-corpuscles may be produced in the spleen, just as in the lymph leaving lymphatic glands corpuscles intermediate between colourless and coloured are not infrequently found.

(3) The spleen may also be regarded as a diverticulum of the gastric circulation. During gastric digestion it is small, enlarging after its conclusion. Any obstruction to the circulation through the liver is accompanied by enlargement of the spleen. This is explained by the fact that the portal vein, which breaks up into capillary branches in the substance of the liver, is formed by the junction of veins from the spleen, and from the stomach and intestines.

The spleen may be removed from the body without serious result, the chief effect being that the lymphatic glands and red marrow of bone become enlarged and appear to take on compensatory functions.

Thyroid Gland.

The *thyroid* gland is a small two-lobed organ, situated in front of and on each side of the upper part of the trachea in the neck. Its weight is from one to two ounces, greater in females than males. It consists of a capsule and trabeculæ of connective tissue, enclosing spherical or oval vesicles, about $\frac{1}{500}$ of an inch in diameter. Each vesicle is lined by a single layer of epithelium, and the cavity contains a viscid mucinous fluid. The vesicles are surrounded by blood-vessels and lymphatics, and, according to Baber, the viscid fluid is secreted by the epithelial cells and reabsorbed by the lymphatics, whence it ultimately reaches the circulation.

According to Simon, the thyroid gland forms a diverticulum of the cerebral circulation, as the spleen does of the gastric circulation, and the thymus gland of the pulmonary (during fœtal life). Luschka considered that its function was chiefly mechanical, warding off the pressure of the muscles of the neck on the carotid arteries, which supply the blood with brain. The vesicles have been found to contain altered and broken-up red corpuscles, and it may be that the gland has an influence like the spleen in determining the existence of the red corpuscles. Recent researches have thrown much additional light on the functions of the thyroid gland. Mr. Victor Horsley has conclusively shown, as the result of careful experiments made at the Brown Institution, in Wandsworth-road, that extirpation of the thyroid gland in monkeys is followed by tremors, pallor, excess of white corpuscles in the blood, increasing mental dulness, and death by coma in from five to seven weeks. The face and the eyelids were swollen, and the hair of the body was atrophied. After death, mucin, a chemical substance not normally present in the blood, was found in it; the subcutaneous tissues were sticky and swollen from its presence, and the connective tissue of the whole body was infiltrated with the same material.

In connection with these experiments, it is important to note the existence of a disease in women (and more rarely in men) which was first described by Sir W. Gull under the name of a "cretinoid condition," and has since been more thoroughly investigated and explained by Dr. Ord, and named by him myxœdema (*i.e.*, mucous swelling). In this disease the patient becomes dull and slow in her movements, the face looks swollen and puffy, and its movements are stiff and slow, the patient gradually becomes more lethargic and ultimately dies. After death all the tissues are found infiltrated with mucin, and the thyroid gland is atrophied, if not entirely absent. There is a similar lack of development of the gland in cretins.

The carefully-substantiated results of these painless experiments on monkeys illustrate the value of such investigations to human beings. In goitre the thyroid gland becomes greatly enlarged, owing, according to some, to the drinking of the hard water of magnesian limestone districts, though there seems to be some connection between the carrying of heavy weights on the head and the development of this disease in hilly regions. If the goitrous swelling is very large it may press on the trachea, and even produce suffocation. The remedy suggested was the removal of the entire thyroid gland, a dangerous though feasible operation. But such an operation meant the subsequent development of myxœdema, as the experiments on monkeys proved. Hence the substitution of another operation which relieves the pressure on the trachea, but does not involve the removal of the gland. This is the division of the middle lobe of the gland, and turning the two halves aside, thus relieving the pressure on the front of the trachea, but leaving the gland intact. The latter operation has been successfully effected.

Suprarenal Bodies.

The *suprarenal* bodies are minute organs, each weighing from one to two drams, and lying, as the name indicates, above the corresponding kidney, just below the posterior part of the diaphragm.

There is a fibrous capsule, from which septa and trabeculæ run in, dividing the organ into spaces, in which cellular elements are contained. The groups of cells are arranged differently in the outer and the inner part of the organ, and in the inner part many larger cells are present, some of them branched, and apparently connected with the very numerous nerve-fibres which run into the organ.

The function of the suprarenal bodies is somewhat doubtful. They belong to the class of blood-vascular or ductless glands, and probably have some modifying influence on the composition of the blood. The abundant nervous supply which they receive from the sympathetic system (quite disproportionate to their size) indicates other obscure nervous functions; and in this connection it is interesting to note the only fact positively known of the functions of these obscure organs—a fact for which we are indebted to disease, the greatest of experimenters. Dr. Addison first noticed that in a disease which was named after him Addison's disease, and which was characterised by frequent nausea, a coppery discolouration of the whole skin, and gradually increasing, and ultimately fatal nervous prostration; the only constant lesion found after death was a tubercular disease of the suprarenal bodies. The effect on the colour of the skin (from alterations in the colouring matter of blood corpuscles), and the intense nervous prostration in disease of this organ, indicate its important influence on the condition of the blood and the nervous system.

(*To be continued.*)

CHEERFULNESS.

Lively.
mf
1st TREBLE.
2nd TREBLE.
BASS.
cres.
1. A light-some heart and a cheer-ful mind Are trea-sures worth pos-sess-ing; Con-
2. A plea-sant glance and a joy-ous song Some faint-ing heart may strength-en; As
3. Dread not the threat-en-ing ills of life, And nought but er-ror fear-ing; Let
KEY F. mf Lively.
CHORUS.
tent-ment is a vir-tue rare, And joy a heaven-ly bless-ing.
sun-ny rays warm cheer-less days, And hours of bright-ness length-en.
each one help his neigh-bour on— Be each his bro-ther cheer-ing.
Then sing a-loud, each
C. t.
f. F. CHORUS.
pass-ing cloud Will show its sil-ver lin-ing: Take cheer, al-though 'tis dark be-low, The
sun is o'er us shin-ing; Take cheer, al-though 'tis dark be-low, The sun is o'er us shin-ing!

Easy Steps in Trigonometry.

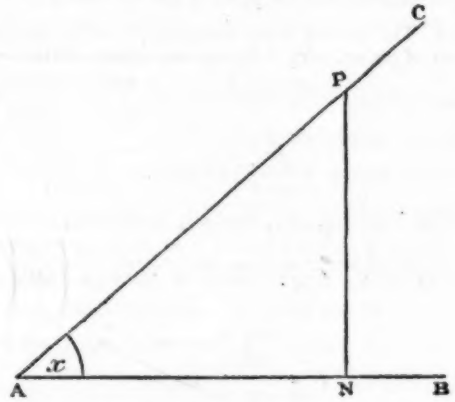
BY REV. A. D. CAPEL, M.A.,
Author of 'Catch Questions in Arithmetic,' etc., etc.

CHAPTER I.

1. The student is supposed (at present) to have only the ordinary conception of a rectilineal angle, which he obtained from his study of geometry. In this chapter we shall not refer to any angle greater than a right angle.

2. A ratio between two quantities, which must be of the same kind, or capable of being reduced to the same kind, is a comparison as to how many times the former contains the latter, and may be written thus, 9 in. : 3 in. or $\frac{9 \text{ in.}}{3 \text{ in.}}$

3. Since $\frac{9 \text{ in.}}{3 \text{ in.}} = 3$ times, a ratio is abstract, and therefore ratios can be multiplied together, or added, or raised to any power; and, in fact, any arithmetical operation can be performed on and with them; thus, there is nothing absurd in multiplying £4 6s. 7d. by the ratio $\frac{5 \text{ men}}{7 \text{ men}}$, nor in dividing the ratio $\frac{£6}{£7}$ by the ratio $\frac{5 \text{ lbs.}}{7 \text{ lbs.}}$, nor in raising that between $\frac{5\text{s. } 3\text{d.}}{6\text{s. } 7\text{d.}}$ to the fourth power or in finding its cube root.



4. Let CAB be an acute angle. In CA take *any* point P, and from P draw PN perpendicular to AB. Let the angle PAN contain x angular units, where x is a number, and the unit is some fraction, it does not matter what, of a right angle.

5. We now have a right-angled triangle PAN, containing as one of its acute angles the angle x. PA, the side opposite the right angle, is called the hypotenuse, which we will contract into hyp. PN, the side opposite the angle x, is called *its* perpendicular, which we will contract into perp; and AN the other side adjacent to the angle x is called *its* base.

6. With these three sides, PN, NA, and AP, we can form six ratios, to which in Trigonometry we assign technical names as follows.

7. The ratio $\frac{\text{PN}}{\text{PA}}$, or $\frac{\text{perp}}{\text{hyp}}$, is called the sine of the angle x, and is written sin x.

The ratio $\frac{\text{PA}}{\text{AN}}$, or $\frac{\text{hyp}}{\text{base}}$, is called the secant of the angle x, and is written sec x.

The ratio $\frac{\text{PN}}{\text{AN}}$, or $\frac{\text{perp}}{\text{base}}$, is called the tangent of the angle x, and written tan x.

8. The complement of an angle is its defect from a right angle. Since the angle PNA is a right angle, the angle APN is the complement of PAN, and, of course, PAN is the complement of APN; or in other words they are complementary to one another.

9. With respect to the angle APN, AN is the perp, being opposite to the angle, and PN the base, the hyp being the same. Therefore the ratio $\frac{\text{AN}}{\text{PA}}$, or $\frac{\text{base}}{\text{hyp}}$, with regard to the angle x, is $\frac{\text{perp}}{\text{hyp}}$ with regard to APN, or sin APN, or sine of complement of the angle x, and therefore called the cosine of x, and written cos x; the syllable, 'co' being short for 'of the complement,' or 'complement's.'

Similarly the ratio $\frac{\text{AP}}{\text{PN}}$ is the secant of APN, or the secant of the complement of the angle x, that is, cosecant x, written cosec x.

And the ratio $\frac{\text{AN}}{\text{NP}}$ is the tangent of APN or the tangent of the complement of the angle x, that is, cotangent x, which is written cot x.

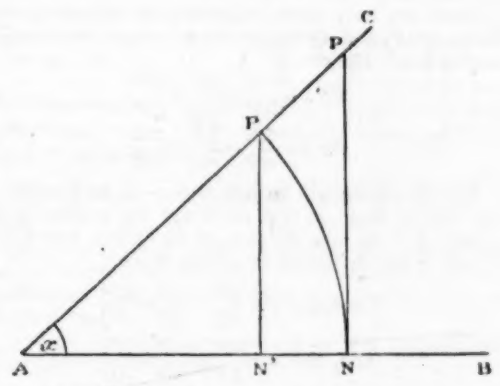
10. $\text{Sin } x = \frac{\text{PN}}{\text{AP}} = \frac{1}{\frac{\text{AP}}{\text{PN}}} = \frac{1}{\text{cosec } x}$.

And similarly $\text{cosec } x = \frac{1}{\sin x}$, or the sine and cosecant are reciprocals.

Similarly $\cos x = \frac{1}{\sec x}$ and $\tan x = \frac{1}{\cot x}$.

11. As a little piece of memoria technica the student may notice that the sine and tangent have the perpendicular as their numerator, of which the initials s, t, p, are late in the alphabet; whereas the cosine and cotangent have the base as their numerator, of which the initials c, c, b, are early in the alphabet.

12. In the three pairs of reciprocals it may be noticed that each pair has a ratio beginning with 'co,' and that the reciprocals tan and cot are the only pair that are so related, the other pairs being sine and cosecant and cosine and secant.



13. Draw the same figure as before, and with centre A, distance AN, describe a circle cutting AP in P', and from P' draw P'N perpendicular to AB.

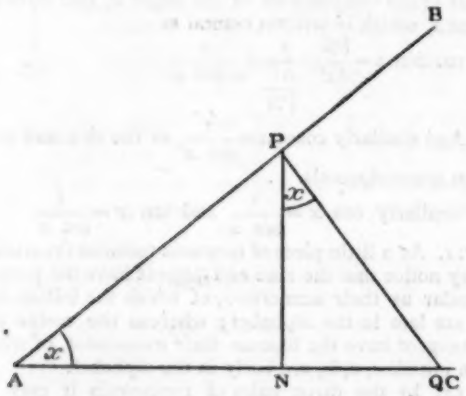
14. The triangles PAN and P'AN' being similar, the ratio $\frac{P'N'}{AP'}=\frac{PN}{AP}$ (Eucl. VI. 4); hence it in no way affects the ratios, called goniometrical, with regard to any angle, how long the lines AP, etc., are.

15. Let us write down the ratios of the angles with the radius of the circle as the consequent or second term of the ratio; and let this radius = 1. Then $\sin x = P'N'$; $\cos x = AN'$; $\tan x = PN$; $\sec x = PA$; $1-\cos x = N'N$.

16. $1-\cos x$ is called the versed sine of x, and written vers x, and, similarly, $1-\sin x$ is called the coversed sine of x, and is written covers x.

17. If we consider the portion of the circle P'N, as half a bow, which half is called the arc of the angle x, and P'N' the half of the string of the bow; and N'N the arrow, the student will see why P'N' is called the sine (*sinus* a bosom, to which the string of the bow was drawn), and N'N the sagitta (arrow), the old name for the versed sine. The names of PN, tangent (touching), and PA, secant (cutting), are self-evident.

18. The student must now learn some connections between these ratios, just as he learns his addition and multiplication tables in arithmetic.



19. Let CAB be any acute angle. In CA take any point P, and from P draw PN perpendicular to AB, and PQ at right angles to AC, meeting AB in Q. Then the angle QPN is = a right angle less NPA = PAN, or x.

Now we have three right-angled triangles, viz., PAN, QAP, and QPN, of which one of their acute angles is x. Hence

$$\sin x=\frac{PN}{AP}=\frac{QP}{AQ}=\frac{QN}{QP}$$
$$\cos x=\frac{AN}{AP}=\frac{AP}{AQ}=\frac{PN}{PQ}$$

$(\sin x)^2$—generally written $\sin^2 x$—is the product of any two of these, as well as of any one multiplied by itself. Let us take the two, of which the numerator of one is the denominator of the other.

$$\text{Thus, } \sin^2 x=\frac{QP}{AQ}\times\frac{QN}{QP}=\frac{QN}{AQ}$$
$$\text{and, } \cos^2 x=\frac{AN}{AP}\times\frac{AP}{AQ}=\frac{AN}{AQ}$$
$$\text{therefore, adding } \sin^2 x+\cos^2 x=\frac{QN+AN}{AQ}=\frac{AQ}{AQ}=1$$

which we will call Formula 1.

20. Let the student now write down the three ratios = sec x, and the three = tan x. Then let him choose those two, in either case, of which the numerator of one is the denominator of the other, and subtract; he will prove

$$\sec^2 x-\tan^2 x=1. \qquad \text{(Form. 2.)}$$

and lastly, in a similar way, he can prove

$$\operatorname{cosec}^2 x-\cot^2 x=1. \qquad \text{(Form. 3.)}$$

21. There are two other formulæ in single angles of very constant use, which the student must be able to apply just as readily as he can use such a fact as $7\times 7=49$.

$$\tan x=\frac{\text{perp}}{\text{base}}=\frac{\frac{\text{perp}}{\text{hyp}}}{\frac{\text{base}}{\text{hyp}}}=\frac{\sin x}{\cos x} \qquad \text{(Form. 4.)}$$

$$\cot x=\frac{\text{base}}{\text{perp}}=\frac{\frac{\text{base}}{\text{hyp}}}{\frac{\text{perp}}{\text{hyp}}}=\frac{\cos x}{\sin x} \qquad \text{(Form. 5.)}$$

Since the cotangent is the reciprocal of the tangent, we might have deduced this expression for the cotangent from that of the tangent.

22. Similarly, any ratio can be expressed in terms of two others, but the student need not burden his memory with them at present, though they will be given as problems for proof in the exercises.

23. The student is recommended to write on a large sheet of paper, with a figure, the names of the eight goniometrical ratios, thus:—$\sin x=\frac{PN}{AP}$ or $\frac{\text{perp}}{\text{hyp}}$, etc.; then the reciprocals thus:—

$$\sin x=\frac{1}{\operatorname{cosec} x} \text{ or } \operatorname{cosec} x=\frac{1}{\sin x};$$

and then the formulæ, carefully numbered, thus:—

Form. 1. $\sin^2 x+\cos^2 x=1$, or $\sin^2 x=1-\cos^2 x$,
or $\sin x=\pm\sqrt{1-\cos^2 x}$, or $\cos^2 x=1-\sin^2 x$,
or $\cos x=\pm\sqrt{1-\sin^2 x}$, etc., etc.

Form. 5. $\tan x=\frac{\sin x}{\cos x}$ or $\sin x=\tan x\ \cos x$,
or $\cos x=\frac{\sin x}{\tan x}$.

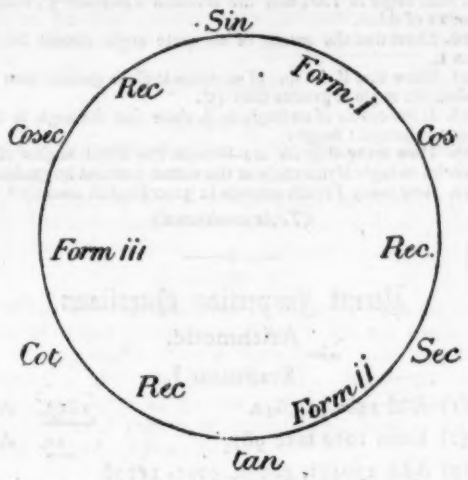
24. We are now in a position to prove any identities only involving the ratios with respect to single angles.

e.g. Prove $\sin^4 x-\cos^4 x=1-2\cos^2 x$.

The working would be thus:—

$\sin^4 x-\cos^4 x=(\sin^2 x+\cos^2 x)(\sin^2 x-\cos^2 x)$
Apply Form. 1 $=1\times(\sin^2 x-\cos^2 x)$
(but the factor 1 can be eliminated).
Apply Form. 1 again $=1-\cos^2 x-\cos^2 x$
$=1-2\cos^2 x.$

Prove $\frac{\sec^2 x}{\cot x}=\frac{\sin x}{\cos^2 x}$
By recip. $=\tan x\sec^2 x$
By Form. 4 and recip. $=\frac{\sin x}{\cos x}+\frac{1}{\cos^2 x}$
$=\frac{\sin x}{\cos^3 x}.$



25. The above figure connects the six principal ratios together cyclically. From the sine we can immediately get the cosine by Form. 1, or the cosecant by its being its reciprocal. If we want to find the tangent from the sine, it does not matter which way we go; but if we want to find the cotangent, we had better pass through the cosecant. Similarly, to get the cosine from the tangent, pass through the secant; but to get the cotangent from the cosine, it does not matter which way you go.

26. EXAMINATION AND EXAMPLES.—I.

1. Let ABC be any triangle; from A the vertex draw AD, perpendicular to base BC (produced, if necessary), and write down all the ratios with respect to angle BAD.

2. Show that $1 - \sin x$ is the versed sine of the complement of x.

3. As in paragraph 13, draw a figure which will represent the cosecant and the cotangent referred to the radius of the circle as the consequent.

4. Show that if the sine of the angle is equal to the cosine, the angle is half a right angle.

5. Prove $\cos x = \dfrac{\cot x}{\operatorname{cosec} x}$.

6. Prove $\operatorname{covers} x = \dfrac{\sec x - \tan x}{\sec x}$.

7. Prove $\operatorname{vers} x = \dfrac{\sin x}{\operatorname{cosec} x + \cot x}$.

8. If $\sin x = \frac{1}{3}$, find $\cos x$ and $\tan x$.

9. Prove $(\sin x + \cos x)^2 + (\sin x - \cos x)^2 = 2$.

10. Prove $\sin^6 x + \cos^6 x = 1 - 3\sin^2 x + 3\sin^4 x$.

11. Apply Euclid I. 47 to half an equilateral triangle described on 2 in., and find the ratios of the angles of an equilateral triangle.

12. Prove $\sin x \sec x = \pm\sqrt{\sec^2 x - 1}$.

13. If $\cos x = \frac{A}{B}$, find $\cot x$.

14. If $\operatorname{covers} x = \frac{1}{5}$, find $\tan x$.

15. Prove that the tangent of any acute angle is greater than the sine of the same angle.

16. The sine of an angle is $\frac{3}{4}$ of the cosine: what is the versed sine of the angle?

17. If the cosecant of an angle is 3 times the tangent, find the sine.

18. Prove $\sin x \cos x = \dfrac{\sqrt{1+\cos x \tan x}\ \sqrt{1-\cos x \tan x}}{\sec x \cot x}$

19. Prove $\cos x = \dfrac{\sqrt{\operatorname{cosec}^2 x - 1}}{\operatorname{cosec} x}$

20. Prove $\sin x - \cos x = \sqrt{\dfrac{\sec x - 2\sin x}{\sec x}}$

21. Prove $1 - \tan x = \sqrt{\sec^2 x - 2\sin x \sec x}$.

22. Prove $1 + \cot x = \sqrt{\operatorname{cosec}^2 x + 2\cos x \operatorname{cosec} x}$.

23. Prove $\sin x = \sqrt{\sin^2 x - 1 - \sin^4 \sec^2 x + \sec^2 x}$

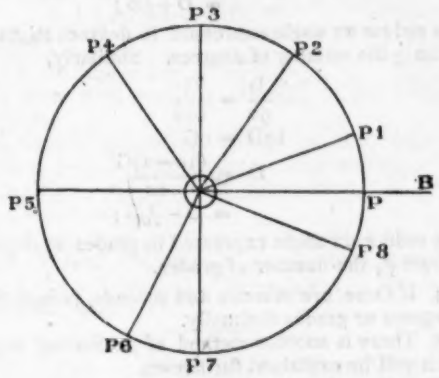
24. Prove $\operatorname{vers} x = \dfrac{\sec x - 1}{\sqrt{1+\tan^2 x}}$

25. Prove $\operatorname{cosec}^4 x - \cot^4 x = \operatorname{cosec}^2 x + \cot^2 x$.

26. Prove $\sec^2 x + \operatorname{cosec}^2 x = \sec^2 x \operatorname{cosec}^2 x$.

CHAPTER II.

ENGLISH AND FRENCH MEASUREMENT OF ANGLES.



27. Let OB be a horizontal straight line, of which O is a fixed end. In OB take any point, P, and imagine another line, OP, lying on OB. Whilst OB remains fixed, let OP revolve in a direction contrary to the way in which the hands of the clock go, and let P stop at any point, such as those marked P_1, P_2, ... P_8, all of which are necessarily on the circumference of the same circle. In trigonometry we measure all the angles BOP_1, BOP_2, ... BOP_8, by the fraction of the circumference of the circle the point P has passed through. In Euclid BOP_8 is a very small angle, but in trigonometry it is very large—more, in fact, than double the angle BOP_4.

28. Euclid VI. 33 proves that the arcs PP_1, PP_2, are in proportion to the angles they subtend at the centre of the circle. One way, therefore, of measuring an angle is to compare with the entire circumference the arc it (when placed at the centre of a circle) subtends.

29. In England it has been agreed to divide the circle into 360 equal parts, called degrees, written thus 360°; and to subdivide these degrees into 60 equal parts, called minutes, written 60′; and to subdivide these again into 60 equal parts, called seconds, written 60″.

30. Since all the angles that can be formed at a point are equal to 4 right angles, a right angle must contain 90°, and the angle which PO makes with OP_5 (or a straight line) is 180°.

31. We can have angles greater even than 360°, as we can carry P round the circle as often as we like.

32. In France the circle is divided into 400 grades, and these subdivided into 100 French minutes, written 100′; and these minutes into 100 French seconds, written 100″.

33. To connect the measure of the same angles expressed by these units:—

Since 11°, 17° ...D° are $\frac{11}{90}$, $\frac{17}{90}$ ... $\dfrac{D}{90}$ of a right angle

and 12^g, 18^g...G^g are $\frac{12}{100}$, $\frac{18}{100}$ ... $\dfrac{G}{100}$ of a right angle.

If D° and G^g represent the same angle, $\frac{D}{90}$ and $\frac{G}{100}$ are equal to one another. Hence,

$$\frac{G}{100} = \frac{D}{90}$$
$$9G = 10D$$
$$G = \frac{(9+1)D}{9}$$
$$= D + \tfrac{1}{9}D;$$

or to reduce an angle expressed in degrees to grades, add on $\frac{1}{9}$ the number of degrees. Similarly,

$$\frac{D}{90} = \frac{G}{100}$$
$$10D = 9G$$
$$D = \frac{(10-1)G}{10}$$
$$= G - \tfrac{1}{10}G;$$

or to reduce an angle expressed in grades to degrees, subtract $\frac{1}{10}$ the number of grades.

34. If there are minutes and seconds, reduce them to degrees or grades decimally.

35. There is another method of measuring angles which will be explained further on.

36. Reduce $63^\circ\ 6'\ 45''$ to grades, etc.

60 | 45· seconds.
60 | 6·75 minutes.
9 | 63·1125 degrees.
7·0125 one-ninth.
Adding we get 70·1250 grades.

$70^g\ 12'\ 50''$. Ans.

Reduce $63^g\ 14'\ 10''$ to degrees, etc.

63·1410 grades
6·3141 one-tenth.
Subtract, we get 56·8269 degrees
60
49·6140 minutes
60
36·840 seconds.

$56^\circ\ 49'\ 36{\cdot}84''$. Ans.

37. EXAMINATION AND EXAMPLES.—II.

1. Reduce $35^\circ\ 10'\ 36''$ to grades, etc.
2. Reduce $25^g\ 32'\ 50''$ to degrees, etc.
3. One acute angle of a right-angled triangle contains as many grades as the other does degrees; find them.
4. How many more grades are there in the angle of a regular hexagon than degrees is the angle of a regular pentagon?
5. Find the number of degrees, etc., in ·255 of a right angle.
6. The angles of a quadrilateral inscribed in a circle, taken in order when multiplied by 1, 2, 3, 4 respectively, are in arithmetical progression; find them.
7. The number of the sides of two regular polygons are as 2 : 3, and the number of grades in an angle of one equals the number of degrees in an angle of the other. Find how many sides they each have.
8. Prove $\sin 45^\circ = \cos 50^g$.
9. If one-third of a right angle be assumed as the unit of angular measurement, what will represent an angle of 75°?
10. Determine the number of degrees, etc., in the unit of angular measurement when an angle of 66·6 grades is represented by 20.
11. What is the complement of $35^g\ 47'\ 33''$?
12. Reduce the complement of $33^\circ\ 1'\ 12''$ to grades, etc.
13. Show that the sine of an acute angle can never be as great 1.
14. If the tangent of 60° be $\sqrt{3}$, find the cosecant of $33\frac{1}{3}$ grades.
15. The interior angles of an irregular polygon are in A.P., the least angle is 120°, and the common difference 5°, find the number of sides.
16. Show that the secant of an acute angle cannot be less than 1.
17. Show that if the sine of an acute angle is greater than the cosine, the angle is greater than 45°.
18. If the cosine of an angle be $\frac{1}{2}$, show that the angle is that of an equilateral t iangle.
19. How many degrees are there in the equal angles of an isosceles triangle if the angle at the vertex contains 20 grades?
20. How many French seconds in 3240 English seconds?

(To be continued.)

—o—

Recent Inspection Questions.

Arithmetic.

STANDARD I.

(1) Add 1482,729,642. 2853. Ans.
(2) From 1012 take 987. 25. Ans.
(3) Add 130451, 48930, 5001, 11798 196,180. Ans.
(4) From 138,475 take 49,249. 89,226. Ans.

STANDARD II.

(1) Multiply 107,001 by 9. 963,009. Ans.
(2) Divide 422,006,576 by 73. 5,780,912 Ans.
(3) Multiply 1470 by 432. 635,040. Ans.
(4) Divide 2,075,998 by 5489. 378 + 1156. Ans.

STANDARD III.

(1) £642 16s. + £1426 18s. 6d. + £2406 19s. + £897 + £786 16s. 8d. + £2704 17s. 8½d. + £786 14s. £9652 1s. 10½d. Ans.
(2) £345 − £129 17s. 8¾d. £215 2s. 3¼d. Ans.
(3) Multiply eight hundred and four pounds and sevenpence by six hundred and fifty-eight. £529,051 3s. 10d. Ans.
(4) Divide one pound nineteen shillings elevenpence three farthings by one thousand nine hundred and nineteen. One farthing. Ans.

STANDARD IV.

(*Card A.*)
(1) Add $\frac{1}{5}$ of $\frac{3}{4}$ of $\frac{4}{5} + 5\frac{1}{2} + \frac{9}{19}$. $5\frac{53}{190}$ Ans.
(2) Find the value of $\frac{21\frac{7}{8}}{4\frac{3}{4}}$ of $\frac{10\frac{5}{7}}{7\frac{1}{2}}$ of $\frac{77}{340}$ of 27s. 48. 8d. Ans.
(3) Bought 29 cwt. 3 qrs. 8 lbs. soap, at £3 12s. 8d. per cwt., how much did I pay for the whole? £351 15s. 8¼d. Ans.
(4) A tea dealer bought 4 chests of tea, each weighing 37 lbs. 7 oz., for £63 14s. 6d., what did the tea cost him per ounce? 6¼d. Ans.

(*Card B.*)
(1) Add the sum and difference of $\frac{4}{5}$ of 3 guineas and $\frac{2}{3}$ of £4. £5 6s. 8d. Ans.
(2) If 8 men can dig a trench 100 ft. long, 3 ft. broad, and 4 ft. 6 in. deep, in 9 hours, how many will be required to dig a trench 80 ft. long, 5 ft. broad, and 2 ft. deep, in $5\frac{1}{3}$ hours? 8 men. Ans.
(3) Express as decimals $243\frac{21}{100} - \frac{0.042\,13}{1\,000\,000}$. 242·245787. Ans.

(4) Required the amount of £346 for 3 years, at £4 10s. per cent., at compound interest.

£497 10s. 11¼d. Ans.

Dictation.

STANDARD II.

'Dick Bell was a bad boy. He did not do as he was bid. His mother had told him not to take the birds' nests; for she said that this was cruel to the birds, and gave them pain. But Dick did not mind what was said to him.'

STANDARD III.

'When water is made hot some of it rises in the shape of steam or vapour. The clouds are made of this vapour, which, when it gets quite cool, becomes water again, and falls down as rain. Sometimes the wet vapour in the air freezes on the trees, and makes them look as if they were covered with silver. Then we call it rime, or hoar frost.'

STANDARD IV.

'"Now," said Uncle Robert, "to make this pudding we must first have flour; and how many people must have laboured to procure it! The ground must have been ploughed, and sowed, and harrowed, and reaped. To make the plough, miners, smelters, and smiths—wood-cutters, sawyers, and carpenters—must have laboured.

'"The leather of the harness for the horses had to be tanned, and prepared for the harness-maker. Then we have the builders of the mill, and the men who quarried the mill-stones, and made the machine-work of the mill."'

Grammar.

STANDARD II.

(1) What is an article?

(2) What is an adjective?

(3) Pick out the adjectives in the following phrases:—A large room. An old book. Black ink. Good children.

(4) Put the indefinite article before each of the following words:—Pen, eye, house, history.

STANDARD III.

(*Card A.*)

(1) How many kinds of nouns are there?

(2) What is a collective noun?

(3) How many genders are there? When is a noun said to be of the common gender?

(4) How many numbers are there? What nouns form the plural by adding *es*, and *f* or *fe*, separately?

(*Card B.*)

(1) Distinguish transitive and intransitive, reflective and passive verbs, the principal tenses of the verb, present and past participles.

(2) State the difference between an adjective and an adverb.

(3) Name the relative pronouns, and show by examples how they are used.

(4) Parse—'He is idle who might be better employed.'

STANDARD IV.

(*Card A.*)

(1) Write four words containing the following prefixes:—*A*, *re*, *over*, *im*.

(2) What are the verbs signifying *to make*, from *cheap*, *public*, *civil*, *hard*.

(3) Form sentences, each consisting of a subject, predicate, and object.

(4) Parse the words in italics and analyse the whole:—

'"And *wherefore do* the poor *complain?*"
The *rich* man asked *of me;*
"Come, *walk* abroad with me," *I said,*
"And I will *answer thee.*"'

(*Card B.*)

(1) State the position of adverbs.

(2) After what words is the sign of the infinitive omitted?

(3) Correct anything wrong in the following sentences:—You write elegant. The animals whom you describe. He come at dinner time. If I were him, I would act different.

(4) Analyse:—'After wandering for some time among the huge fragments of granite which skirted the base of the overhanging precipices, she at last found a sheltered nook.'

Lectures on Shakspere's 'King Lear.'

BY H. MARMADUKE HEWITT, M.A., LL.M.

Late Assistant-Examiner in the University of London.

NO. I.—INTRODUCTORY; AND REMARKS ON ACT I., SC. 1.

THERE is something striking in the idea of a large number of young people being engaged simultaneously in the study of a particular book. For many years this has been the case in England. Though we have not yet reached that stage of uniformity which once enabled a public functionary to declare that he could name the book, and almost the page of the book, that was being studied at that precise moment in all the schools of his native country, and though such absolute uniformity would here, perhaps, be thought most undesirable, we are continually prescribing the same book, or portion of a book, as mental pabulum for large numbers both of boys and older students. Take, for instance, certain plays of Shakspere. On some half-dozen of these the Syndicates of the Oxford and Cambridge 'Local' Examinations are accustomed to 'ring the changes'; so that for a whole year one or other of these plays is studied in the schools which furnish the Examiners with those hosts of juvenile candidates, and tons of copies of the same annotated edition are thumbed simultaneously by groups of school-boys from London to the Land's End, and from the Midlands to merry Carlisle. Often, too, some play of Shakspere is being read by a vast number of young men who are preparing themselves to give instruction in the Public Elementary Schools of this country.

To us it seems a most fit and proper thing that English youths should study English writers. The Greeks studied Homer. The boys of ancient Rome, as many of us have read in Juvenal, occupied their school hours with the writings of Horace and Virgil, and, possibly enough, may have given some attention to the plays of Terence and Plautus. If they did, the parallel between the Roman and English schools would be fairly complete; for to the boys of Juvenal's

time both the grammar and orthography (as we should now say) of the last-mentioned writers must have appeared decidedly old-fashioned, just as the language of Shakspere's plays seems antiquated enough to the youth of modern England. We are not speaking here of the relative importance of English and Classical studies, or we might be tempted to lay stress upon the fact that, in order to pursue their education on what was, until quite lately, the plan adopted in our own schools, the Roman boys ought to have eschewed both Horace and Virgil as too modern for educational purposes, and have spent their efforts either upon scraps and fragments of ancient Etrurian or upon Homer and other writers of ancient Greece, or, perhaps, upon books in the language of Carthage. We find no indications of this idea, though certainly the best-educated Romans learned to speak Greek, which was then a living language, much as educated Britons now learn French. This was only natural, seeing that the Roman world had been leavened by Greek ideas much as England has been pervaded by French fashions.

The play of 'King Lear' is to be studied during the next few months by a large number of young men who hope to become teachers. One object, therefore, in this series of articles will be to call attention to as many as possible of the grammatical and other difficulties of the text, in order that our remarks may be of service, if possible, to those who are getting up the play for 'examinational' purposes. To 'get up' a play thoroughly is an occupation that requires time and trouble, and talking over matters with some one else (as most students have noticed) tends much to their simplification. Nor need the student disdain further assistance, even though he be furnished with an annotated edition. Before he can feel the assurance that he knows all about his subject, even though it be of no more than moderate length, he must turn it and twist it—look at it this way and that way—and satisfy himself that no difficulty remains unsolved, that no passages are misunderstood, and even that no points, although simple, are in danger of being lost sight of at the critical moment through the shortcomings of a treacherous memory. The ideas of some students, when in examination, are apt, like Bob Acres's courage, to ooze out at their fingers'-ends, and the advantages gained by frequently going over the work beforehand are wont to show themselves conspicuously on such trying occasions. Hence, though we can hardly hope to offer much that is absolutely new, or that the student may not obtain from some one or other of the existing books, we hope that by going over the ground in the company of an independent mind he will end by seeing a few things, at all events, clearer than he did before, and have his attention directed to *some* points, to say the least, which he might have overlooked unaided. And we feel sure that the student will recollect his work none the worse for our having travelled over the ground together.

We by no means propose, however, to limit our remarks to peculiarities of grammar. Could we see and speak with our readers, an exclusive attention to these points would weary and perhaps disgust them. It is one of the penalties of reading for an examination that certain noble literary productions may thereby become distasteful. 'How I hate that play!' remarked a not irrational acquaintance of ours on a recent occasion; 'we sweated over it so, when we were getting it up for exam.' And, indeed, we cannot wonder at this when even a teacher, possibly, is in danger of coming to regard these 'set subjects' merely as collections of hard words and curiously-constructed sentences, which make excellent puzzles, and which he is prepared to investigate and classify, much as the anatomist points out and describes the bones of a skeleton. But work that is disliked is very apt to be forgotten, and few pass creditably in an examination who take no interest in what they are preparing for it.

Now, a good oral teacher would have plenty to say on other topics besides the language of Shakspere, and would consider that *what the poet said* was at least as important as *how he said it*. He would follow up, we think, all the various 'allusions' he met with in the course of the play, and would point out, *e.g.*, the glimpses they afforded of contemporary history, or any opportunities of comparing the past with the present. So, no student should be satisfied with merely mastering the meaning and construction of the words, and getting a sort of general notion of the plot and its development. No, there are the poet's theories of human life to be considered; his pictures of conduct to be criticised; the fidelity to nature of his characters to be discussed; and his speculations on any of the great problems of life and destiny noted and committed to memory. Occupying himself thus, he should proceed till every idea that the play contains has been taken up and assimilated with his earlier mental acquisitions. So treated, the reading of any 'set piece' may form a landmark in a student's intellectual life.

It is scarcely possible, in the limited space at our disposal, to even hint at, much less explain, every noteworthy feature of this play. We shall hope, however, to remove some of the most obvious difficulties from the path of the reader, and to excite an interest in the subject which will aid him in solving the remainder.

We will first indicate certain words and passages of Act I. Scene 1., and afterwards comment upon them, so far as our space permits.

(*a*) Passages of some difficulty:—*Qualities so weighed that curiosity in neither can make choice of either's moiety; where nature doth with merit challenge; beyond all manner of so much; I return those duties back as are right fit; set my rest on; dismantle so many folds of favour; respects that stand aloof from the entire point.*

(*b*) Certain grammatical constructions:—State what rule of grammar is exemplified by—*Our potency made good; As much as child e'er loved; Good my lord; my sometime daughter; Ourself, by monthly course; Be Kent unmannerly, when*, etc.; *answer my life my judgment; I know you what you are.*

(*c*) Nouns, the meaning of which is to be explained:—*Strengths, Albany, nursery, plainness, champain, doom, miscreant, recreant, clamour, disease, dower, argument, benison.*

(*d*) Explanations needed:—*Milk of Burgundy; according to my bond; make from the shaft; in thy best consideration; election makes not up; make such a stray; hit together.*

(*e*) Phrases containing a noun and an epithet:—*Darker purpose; that self way; my very deed of love;*

the blank of thine eye; that little-seeming substance; a still-soliciting eye; waterish Burgundy; washed eyes; unconstant starts.

(*f*) Adjectives: *Brazed, proper, untender.* Verbs: *Affect, owe, digest, reverb, monster.* Participles (?): *Interessed, strangered, long-engraffed.*

(*g*) Quote the allusion to Saturn. An instance of superstition (astrology)? A transposition of the adverb *only*? Some various readings?

(*h*) Paraphrase: (*a*) 'And well are worth the want that you have wanted.' (*b*) 'Who cover faults, at last shame them derides.'

At the very beginning of the play we meet with a passage of some little difficulty. '*Qualities*,' says Gloster, 'are so *weighed*, that *curiosity* in neither can make choice of either's moiety.' We believe the meaning to be this:—The qualities (or advantages) of the several divisions of the kingdom have been so carefully weighed (or set against) each other, that the most careful scrutiny on the part of either donee could not cause him to make choice of that moiety (share) of the kingdom which has been bestowed upon the other. It is intimated that Lear has taken considerable pains to make the shares exactly equal. A page or two later on, the king expresses his intention of conferring his largest bounty 'where nature doth with merit challenge.' What is meant here by *nature* and *merit*? Again, the verb *challenge* usually governs a case, and the expression 'challenge with' is most unusual. Shall we interpret the passage as meaning 'To a person in whom natural and acquired goodness vie with each other'? Lear may have imagined this to be a true picture of his daughter's character. As regards the expression 'challenge with,' we may perhaps compare it with the phrase 'rival with,' which occurs towards the end of this first scene: 'You who with this king hath (hast?) rivalled for our daughter.' Here 'rivalled with' appears to have the meaning of 'contended with,' and justifies us, probably, in interpreting 'challenge with' as meaning 'vie with.' Another somewhat remarkable passage runs—

'Beyond all manner of so much, I love you.'

We fancy that 'manner of so much' means nearly the same as 'estimate of quantity.' Goneril says she loves her father beyond expression. The speaker's words would probably be enforced by gesture. With this use of 'so much' for 'quantity,' we may compare the use of 'where' for 'place' or 'position' in the line—

'Thou losest here, a better where to find.'

Another grammatical tangle meets us in the words of Cordelia's protest, 'I return those duties back as are right fit.' Set a class to write out their several explanations, even with the text open before them, and there will be elicited some curious varieties of opinion. The word *back* we believe to be redundant or pleonastic, *i.e.*, the sense is complete without it. Moreover, '*those*' is here equivalent to '*such*.' The sense of the whole passage is, therefore, 'I, in return, perform such duties as are right fitting.' What these duties are, we are told in the line following. Cordelia displays almost the legal acumen of a Portia when she asks, 'Why have my sisters husbands, if they say they love you all?' She means, if they give all their love to their father, how can they treat their husbands fairly? *All*, of course, is an adverb.

(*To be continued.*)

Science Notes.

IT is only recently that people have become aware of the importance of being periodically weighed. We venture to say that even now a country practitioner would run some risks if he insisted upon weighing and measuring his patients. A person's weight, however, is an important matter. It is important in relation to one's height, and still more important in relation to what it was on former occasions, for variations of weight are the surest guides to variations of health. Those who care to keep a record of their life history should get 'The Life History Album,' by F. Galton, F.R.S. Much valuable information is given, and full directions for making and recording observations. The probable value of such records is pointed out. But while comparatively few will be induced to keep a carefully-tabulated account of themselves for a series of years, all parents and most teachers will be interested in learning what may be called the proper weight and height of a child between the ages, say, of four and fourteen. There are, as we all know, exceptional children—children who have grown too fast, and on that account need to be taken great care of, and children who for various reasons have not grown fast enough, and who, therefore, need to be treated very gently. It is quite easy to find a child's height. The weight is a more tiresome matter. A spring balance can be got for a few shillings, and a little ingenuity enables one to get the weight pretty accurately. The following table gives the average height and weight of boys and girls from four to fourteen,

Age.	Boys.			Girls.		
	Height.		*Weight.*	*Height.*		*Weight.*
	Feet.	Inches	Pounds.	Feet.	Inches.	Pounds.
4	3	2	36	3	1	34
5	3	4	39	3	3½	37½
6	3	6½	42½	3	5½	40½
7	3	9	47½	3	7½	44½
8	3	11	52½	3	9½	49½
9	4	1	57½	3	11½	54½
10	4	3	64	4	2	60
11	4	4½	70	4	4	65
12	4	6	75	4	6½	72½
13	4	7½	79	4	8½	82
14	4	10	87	4	10½	92½

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STUDENTS who are studying that part of physiography which deals with the results of modern physical astronomy will be grateful for having their attention called to a volume on that subject by Miss A. M. Clerke. Those who wish to learn what has been done by photographic and spectroscopic methods will find all they want in this most able epitome. The earnest student is often baffled and disappointed by not being able to gain access to the papers he would gladly read. It would hardly be believed, but it is a fact, that neither the Report of the British Association for the Advancement of Science for 1884, nor that for 1885, was to be found in the reading-room of the South Kensington Library early this year. Full reports of recent scientific research are not at all easy to get at. When such an admirable exposition and summary of modern work as this appears, it is simply an act of gratitude to call attention to it. The title of the book

is 'A Popular History of Astronomy during the Nineteenth Century,' and is published by A. and C. Black.

* *

WE are already feeling the effects of the policy of retrenchment lately adopted by the London School Board; and we all know the contagious influence of example. Members are diligently searching where economies are to begin; and it is thought that extra subjects, and especially scientific subjects, will have very little encouragement. The Education Department has done enough already to discourage the teaching of Natural Science, by insisting that Geography, History, and a knowledge of common things, must all give way to English Grammar, which has now become almost a compulsory special subject. It cannot be proved that the study of natural phenomena is not as good a mental discipline as that of English Grammar, and surely for the working classes of this country it is infinitely more important that they should understand a few of the processes involved in their daily work than be able to analyse a compound sentence. Not one girl in a hundred knows how to light a fire properly or cook a decent dinner; but many girls would pass a creditable examination in the unrealities of English parsing, and point out a noun sentence in apposition with the pronoun 'it.' We trust Professor Gladstone will add another to the many services he has already conferred upon teachers, scholars, and parents, by insisting with all his influence and ability on the necessity for maintaining and extending such science teaching as is now given by the London School Board. It is a circumstance of happy omen that the new vice-president is not only an educationist and a man of culture, but also one of the foremost scientific men of the day. His eminence in that special field is some guarantee that a knowledge of things will not be entirely subordinated to a knowledge of words. There cannot be a better training for a boy's faculties than a study of the things around him, nor a better equipment for success in after-life. We trust that in laudable efforts to save the ratepayers' money the interests of education will not be allowed to suffer.

The Nääs Slojd.

BY MISS J. WARREN,

Inspectress of Infant Schools to the Leicester Board.

(*Continued from page* 556, *vol. v.*)

IN my article of February I gave a brief summary of the ten rules to be observed in the choice of models for a Slojd course, and I now purpose to put before you the eight remaining rules that have to do with the adjustment of these models in an elementary series. I desire, in the course of my description of this manual work, to make my meaning more plain than at present appears, by the addition of minute particulars as to the size, shape, and ultimate use of every model in the series, added to which I hope to give a sketch of the forty articles I have made myself while in Sweden.

I am frequently asked if it is possible to do anything with Slöjd in our country without actually studying and working the system, as I have had the opportunity of doing; and I may be pardoned if I digress for a time to give my opinion on the subject. I have given the matter much deliberate and careful consideration, and I am convinced that with a careful study of the principles underlying the system, added to a thorough knowledge of an elementary education, as it obtains in our own country, with fair trade capacity and intelligent teachers, it is possible for us to get up a Slöjd education far better than any technical training at present in vogue in our elementary schools.

That such a Slöjd will do more than bear a faint resemblance to its parent work, I do not for one moment admit; but I am one of those who believe in the half-loaf theory, and I confidently assert my opinion, that we had better make a feeble attempt at a manual elementary education than let our children pine for want of action; such a trial would at least provoke comment and prevent that stagnation which is acknowledged to be fatal to all advancement; and even while I write these papers I cannot help thinking that I had far better be standing at the bench doing the work of which I write.

The first rule for arranging a series runs thus:—

Rule IX.—That instruction shall be given from simple to complex, easy to difficult.

This rule was found to be very necessary. Some existing Slöjd schools regulate their models by the pernicious plan of demand and supply: they make for the market. Education gets no place in such a system, or, if it does, it is made entirely subordinate. It was also pointed out to us that exhibition was another bar to a perfectly simple grading of the models. After long experience, the Director of Nääs decided to compete at no exhibition for a prize, and only now consents to exhibit the models on the condition that they shall not be put in the award list. The idea is to get in the making of models a series of movements that shall emanate from known prime operations. As in the teaching of reading we proceed from the simple to the complex sounds, so in the wood Slöjd, substituting movement for sound, we get the following *formale* plan:—

Let us suppose our tool manipulations to be *a*, *b*, *c*, *d*. Then the first model in our set must have the elementary movement *a*; the second model may have *b* or *ab*; the third model should have *c*, *bc*, *ba*, *abc*, and so on.

a, by the way, is represented by the knife in the Nääs Slöjd, and the tools were constantly recurring; being so carefully determined and adjusted in the beginning.

Rule XII.—That suitable variation shall be considered in each model in our set.

Children like variety; interest is excited by change, and often the mere movement from one part of the room to another will brighten a child into increased activity; so in the work from model to model we shall endeavour to get as much change as is compatible with a continued and frequent use of the same tools. Wood Slöjd admits of greater variety than any other work. The hundreds of simple useful articles that can be made of wood render it admirably adapted for a school course in manual occupation. Director Saloman would have each town or village possessed of a set of models specially suited to its wants, and yet preserve variety in its arrangement.

Rule XIII.—That the scholar, at whatever step he may be, be found making an exact and useful work.

This rule forms a sort of commentary to Rule XI.; it is a test of the thoroughness of the principles upon

which the whole of the Nääs Slöjd is based. In order to thoroughly appreciate this, one must run through the whole of the subject; the complete harmony and perfection of which can be better imagined than described, when we are able to say that, arrested at any part of its course, the child will be found perfect in that he has done, and that, in his case at least, the 'little knowledge is (not) a dangerous thing.'

Rule XIV.—That the place of each model in the series shall be determined by the fact that it is possible for a child to make the said model entirely without help.

Perhaps this may not be quite plain to some, or may appear to have occurred before, in Rule III. It is not so, however. Negatively it reads that unless the compiler can vouch that the work required in the model is such as to be a well-graded work of that immediately preceding it, and requiring but a moderate advance of manipulative skill on the part of the pupil, it shall not find a place in the series.

Were half the care taken in our elementary intellectual studies, failure in results would be far less frequent. In the arrangement of our models we are not permitted to advance by leaps and bounds.

Rule XV.—That in making the first few models, only a few tools shall be used, but during the progress of the series new tools, and consequently new manipulations, shall be introduced by degrees.

This rule introduces the A B C of movement with regard to tools, for in new tools will, of course, be found new prime operations; these are to be introduced very gradually. The idea is certainly almost identical with that of Froebel, who, in determining a gradual system of hand education, first would have the very young child deal with his Gifts, needing no tools save his own little hands, and afterwards introducing simple tools in his Occupations.

Rule XVI.—That the knife, as an elementary or fundamental tool, shall be much used.

All nations are more or less skilled in the use of the knife; it is therefore considered to be pre-eminently the first tool to take in hand. Several reasons combine to make it advisable that it should have precedence. Boys resort to its use from the very cradle; it is a domestic tool; it is the prelude to other sharp tools; it is small, and can be grasped and used with very little physical force; it is an excellent finger tool, yielding to the simplest movement, and leading up to the most complicated scientific handling, it can, if necessary, take the place of a hundred other tools; so, on account of its great usefulness, it is much esteemed in Nääs, and holds throughout a very important place.

Its danger was fully discussed by all the students of our time, but this is not so great as appears at first sight. With fair use, even a careless child could scarcely injure a vital part, and only to the extent of his own modicum of strength from the wrist. Now, in such a tool as the axe, the whole weight of the arm-force might be brought to bear on a missed stroke. Again, it was urged in its favour that, being a boy's plaything, the sooner his sanguinary struggles with it were over the better for all concerned. It is very certain that those of us who suffered from its use at first were doubly careful afterwards, and I am fain to confess that we didn't learn the lesson by theory.

The third finger of the left hand was very valuable in the manipulation of this particular tool.

Rule XVII.—That in the first models, generally, the very softest woods shall not be used.

In Rule VII. I mention this. Resistance is sometimes better than assistance. When the hand is unskilled, it is correspondingly heavy, and many a model would collapse at one fell stroke, were we to work with soft wood; while, on the other hand, to attempt hard-wood work at first, would be to little children the task of Sisyphus—besides the fact of wasting the wood and causing disappointment. The medium woods afford just the necessary resistance that is wanted to encourage and train the hand in strength and skill.

Rule XVIII.—That the first works, at least, shall be small and quickly finished.

All teachers will certainly agree with me that the reason of this last rule is obvious.

A child tires quickly: we are not to look upon this as a fault, it is a wise ordinance; did he not quickly tire, we, I fear, should forget his childhood—even Pestalozzi was guilty in this respect. No instruction is of use when a child has ceased to attend and interest himself in it; hence the proverbial difficulty with imposition exercises and home lessons.

Our models at first must be small. The child sees to the end; we do not reason with very young children, they are reached through their senses. The size of the model is, therefore, an important factor in this case, as is also the limited number of tools.

Next month I shall have to speak about the age of the scholars, the number in each class, and the time allotted in Sweden to the work.

(*To be continued.*)

Publications Reviewed.

Wall Map of Australia. Edinburgh and London: W. and A. K. Johnston.

Clear in print and colouring, this map, like the other productions emanating from the same firm, is well adapted for class use. The main discoveries of Gregory, Stuart, Gosse, Giles, and other explorers are embodied in the map; but we think the production would have an increased value, especially at the present time, when the commercial aspects of geography are so much to the fore, if a few points in connection with that branch of the science had been attended to. The overland telegraph, for example, from Port Augusta, on Spencer Gulf, to Palmerston, in the extreme north of the island, where it joins the submarine cable to Java and Singapore, might very well have been inserted, as also might the cable communications with New Zealand and Tasmania.

At the risk of repetition, we will again say, as we did in a late review of a map of India, that we do not think English school-maps supply, as a rule, all the information they might. With a little more attention to the advantages of colouring, and with a little more departure from old-fashioned design and style, we are convinced a great deal of information in connection with the mineral wealth, surface contour, manufacturing districts, etc.—which is now only given, if given at all, in special maps—might readily be given in maps for general school use. The great area of vacant sea-space might also be advantageously utilised for giving information respecting the various sea-routes, fisheries, submarine cables, postal services, ocean depths, etc.—information which, as a rule, is now conspicuous by its absence.

There is one other fault too, to which, though not occurring in the map now under our notice, we take the present opportunity of referring, and that is the bad register, which is sometimes apparent in even expensive

maps. The inconvenience and wretched effect of this inaccuracy is generally most conspicuous in those very maps in which the aid of colour is most requisitioned. Take, for example, a map of the West Indies: British possessions are generally coloured crimson; Spanish, yellow; independent, blue; French, green, formed by the superimposition of yellow on blue; Dutch, orange, formed by imposing yellow on crimson, and so on. Where so much depends on the exact imposition of one colour on another, it would be imagined that special care would be taken to effect this object. We will not commit ourselves by saying that special care is not taken; but we will say that in three out of four maps the superimposition of the various colours is not perfect, and that in many a map the simple colours, such as blue and yellow, which should have been coterminous to produce the compound tint, such as orange, are effectively divorced, not only from each other, but from the outline of the island of which they are supposed to denote the nationality—to the confusion rather than to the assistance of the student. As most teachers will be ready to vouch, it is no uncommon thing for the colour of an island to project some ten or fifteen miles, by scale, out to sea one side of the island, and be as many miles inland on the other. We know there are many difficulties, in the shape of shrinkage and expansion of paper and the like, to be encountered in achieving exact register, but we are under the impression that modern science and skill is sufficiently advanced to render it possible to effect better results in map-colouring than is ordinarily now attained.

Illustrations of Trade. London: Educational Supply Association.

This is a series of twelve plates, illustrative of the trades of the baker, tailor, shoemaker, bricklayer, goldsmith, weaver, printer, carpenter and joiner, glassblower, painter and paperhanger, bookbinder, and blacksmith. It will be seen that the selection of trades comprise all those most frequently followed. Judging from the specimens which have come under our notice, the pictures satisfactorily represent the modern aspects of the various avocations, and, being carefully drawn and attractively coloured, are likely to prove both decorative and serviceable for elementary school use.

Written Design. By T. R. Ablett, Superintendent of Drawing to the School Board for London. London: Chapman and Hall.

This is a very ingenious and praiseworthy attempt to amalgamate penmanship with drawing, by making fluent exact handwriting the basis of a flowing and effective style of ornamental design. How this is done can hardly be explained without actual reference to the designs themselves. It must suffice to say that the idea is capitally carried out, and that the pupil who starts work on the first design with a fair idea of writing, is sure to become, by the time he reaches the last, not only a better writer but the possessor of a fair knowledge of ornamental drawing. In short, Mr. Ablett's plan will go far to convert a ready writer into an efficient draughtsman.

Moral Picture Lessons. London: Educational Supply Association.

We cannot say we have had much experience of the moral effect which pictures of this particular nature have on youthful minds; but, judging from the vividness with which we can even now recall particular illustrations that occurred in our early lesson-books a long score years ago, we should say that, unless children's mental capacities have much altered, the pictures now before us are sufficiently vivid and realistic to point many a moral with lasting effect. The six illustrations forming the series are adapted in size and design for class use, and the subjects are carefully selected to 'show up' those faults into which children of both sexes are most apt to fall. The dangerous consequences of throwing stones, playing with fire, etc., are vigorously illustrated, as are also the faults of untidiness, dishonesty, and cruelty to animals. Perhaps the only thing to be wished is that the artist had confined his attention simply to pictures illustrative of 'faulty' children, and had left the conception of 'good' children to be evolved from the inner consciousness of those utilising the pictures. As it is, he has supplied two pictures illustrative of industrious and kind boys and girls, and the amusements these 'good' young people are devoting themselves to are of such a mild and negative description, and the youthful people are themselves so irreproachably tidy and decorous, that we are afraid nine out of every ten little boys would vote the originals outrageous little prigs and muffs, if they ever came across them *in propriâ personâ*. The moral effect of the pictures of bad children runs the risk, therefore, of being counteracted by those of the 'pattern' boys and girls.

Useful Vegetables; Pictures for use in Object Lessons. London: A. Johnston.

We can give unqualified praise to this useful series. The plates are all that could be desired in respect to both drawing and colouring. They are strongly mounted on thick boards, measuring twenty by thirteen inches; and being varnished and fitted with the necessary cards for hanging up, they are quite ready for class use and likely to prove as serviceable as they are attractive. Each plate is accompanied with descriptive letterpress, which will prove of great assistance to the teacher in planning the object lessons.

The Star Primer. By Richard A. Proctor. London: Longmans, Green and Co.

This excellent primer shows, by means of a series of twenty-four hourly maps, the starry sky, week by week, throughout the entire year. Every student of astronomy will welcome this set of star maps. With chart in hand, the star-gazer can readily recognise all the important constellations above his horizon. The pleasure derived from the use of these maps is heightened by the ease with which the various changes in the apparent position of the heavenly bodies are followed, and the causes of these changes inferred. We heartily recommend this series of charts to both teachers and students of either astronomy or physiography. They awaken and stimulate the interest of the learner, and at the same time materially aid the work of the teacher.

Overpressure and Elementary Education. By Sydney Buxton, M.P.

The Truth about Elementary Education. By A. Sonnenschein. London: Swan Sonnenschein, Le Bas and Lowrey, Paternoster Square.

These two books, issued by the same firm, should be read together. The former is by a member of Parliament, who has, we believe, the welfare of the children of England at heart, but who is lacking in the practical experience of the results of the system under which the elementary education of the country is carried on. The other is by a teacher of proved ability, equally anxious for the well-being of the youth of the country, and yet still more anxious that the foundations upon which education is based should be real, that the edifice erected may be substantial and lasting. Both books should be carefully read and studied by every elementary teacher in the country, and especially by those who are connected with the National Union of Elementary Teachers, and who assisted in the outcry about overpressure during the last two years.

Mr. Buxton's volume is the substance of an article contributed by him to the *Nineteenth Century* some months ago, with the addition of many points, involving fresh material for discussion which have come to light since the article appeared. He is of opinion that the importance

of the subject demands its republication in this more accessible and portable form, however imperfectly it may have been handled by the writer.

The work is divided into nine chapters, the principal of which deal with the question, 'Overpressure, Does it Exist?' and 'Payment by Results.' In these chapters the whole ground of controversy between teachers and managers and doctors on the one hand, and the Department and its officials on the other, with respect to these two subjects and their connection with each other is practically covered. The very first adjective used by Mr. Buxton would lead one to see to which side of the controversy he inclines, and a careful perusal of the volume can only be followed by the conclusion that Mr. Buxton held a brief from the Department in this matter. It reads from beginning to end like the memorandum of Mr. Fitch in answer to the report of Dr. Crichton Browne, notwithstanding the statement that the 'question can be discussed calmly and dispassionately, and without party feeling or party bias.' With great unanimity, all teachers will agree with 'the proposition that education should be to the children a pleasure and not a pain, a blessing and not a curse,' and that 'on leaving school they should be morally, mentally, and physically stronger than when they entered it.' It is on these very points that teachers join issue with the supporters of the present system, and we are inclined to take the side of the teachers in this question, practical experience leading us to believe that while there may have been some exaggeration in the outcry made, yet that outcry is the expression of a very substantial evil.

Notwithstanding the possibility of impartiality of investigation, with which the author commences, he immediately falls foul of one section of the advocates of the cry of overpressure, by speaking of the 'animus of some and the ignorance of others.' The doctors and the teachers alike come in for his condemnation; the former because they would not join in upholding the existing state of things, and the latter because, in their plain statement of the cause of overpressure, they showed up the prime blot on our educational system, that of 'payment by results.' The spirit in which the investigation is made may be gathered from the words of the opening chapter: 'We must take things as they are, and not blame Codes or Education Acts because they have not remodelled the world.'

In answering the question concerning the existence of overpressure, Mr. Buxton starts with the statement that he does not deny its existence, but believes that the cry has been very considerably exaggerated. He divides the alleged overpressure into acute cases and general overstrain. The former he narrows down to the cases reported to the Education Department, which were examined during the outcry; and to the latter he answers by quoting the general statistics of mortality of children of school age, especially from zymotic diseases, and the statistics of the Registrar-General respecting mental diseases. We think a sufficient answer to the question is this: The teachers of the country are the best judges as to the existence of this overpressure. They, through their recognised organs and officials, almost unanimously agreed with the general conclusions of Dr. Crichton Browne; they are not so inhuman as to allow the overpressure to continue to the extent of causing death, but every teacher in the country is acquainted with cases of actual injury in the shape of illness, sleeplessness, 'examination fever,' and dulness, caused by the system of *driving* which must be in vogue under present rules, instead of the one of *leading*, which is the true meaning of education. There is no more reason for asking teachers to show the existence of over-pressure by citing cases of death, than there would be in calling upon a medical man to prove his diagnosis of a disease by showing so many deaths before he came to any conclusions in the matter. To tell a medical man that he could not diagnose a case would be called impudence. To tell the 13,000 certificated teachers of the National Union, that they cannot trace to its cause the effects of the system under which they work, is only described by a like word. In examining the remedies suggested by doctors and teachers for this overpressure, Mr. Buxton looks most minutely into those suggested by teachers, and these are his conclusions respecting the increase of payment for average attendance: it 'would tend to diminish the incentive to educational exertion on the part of the teacher .... it would tempt penny wise and pound foolish managers to understaff, and to employ cheap and inefficient teachers; for expense would thereby be saved and the grant scarcely affected.' To this there is a ready reply: even though the whole of the grant were paid for average attendance, no teacher has ever yet made a proposition to take from the Department, or other governing or controlling body, the power of saying how many or what class of teachers shall be employed, or the power of reducing the grant, for inefficiency of instruction or want of suitable apparatus or material employed; nor would there be the possibility of saving expense so long as the income from all sources must equal that from Government grant.

Mr. Buxton complains that teachers should ask for something more than the name being on the register for twenty-two weeks in the way of attendance. Many managers know to their cost what results follow from this regulation. A child may actually have to be examined who has been in school only a score of times, and his failure detract not only from the money earned by the school, but what is more important, its *merit* or reputation. We have in our mind's eye a case now, in which two children, one having attended eleven times, the other nineteen times, were examined. The percentage was thus reduced materially, the grant likewise, and the credit of the school endangered. No liberty of classification, fair to the State or the child, would have made any difference in this case; and yet the managers are made to suffer, even though the grant is paid on the percentage and average attendance, and not on any individual pass. Mr. Buxton, like many other ill-informed persons, ascribes irregularity to the inefficiency of the teacher (p. 30). We do not hesitate to say that this is a libel on teachers. No matter how inefficient a teacher may be, among the thousand and one excuses made for keeping children from school, this is the last that could or would be advanced by anyone acquainted with all the shifts and expedients used by teachers for securing regularity. Nearly forty pages of the volume are devoted to the question of 'payment by results' and its modifications. Mr. Buxton seems to prefer the term 'payment for efficiency,' and argues strongly for the retention of the present system. We cannot reproduce the whole of his argument, but we do not unfairly state it in the following terms: Attendance is essential, and should be encouraged by a special payment; the 'three R's' are essential, and must be compulsory, and to ensure that each child gets his fair share of attention, individual examination is necessary; that the class subjects are optional, and individual examination is therefore not necessary or advisable.

It is to the second of these points that teachers object, and contend that it does not follow, because it is necessary to examine individually, that the practice of payment should be essentially upon the individual pass. Nor does it to us seem consistent that the full grant should be given for good work in the class subjects and only partial payment for better work in essential subjects. Mr. Buxton contends that the payment for the class subjects is but small, while that for the 'three R's' is large. There is not really very much difference between the average amount paid for each; the class subjects last year taking 1·5¾ per pass, and the 'three R's,' reckoned as four subjects, for writing includes spelling, taking 1·8¾, or only ¼ more. Where then would be the evil, or possible inefficiency, in paying the full grant for compulsory subjects in the same form as the class subjects? If Mr. Buxton will turn to the suggested amendments of the propositions for a new code issued by Mr. Mundella, he will find there such points as would, if adopted, have guaranteed efficiency equal to the present, without the disadvantages

arising from the over-work, over-worry, and over-pressure now existing. Mr. Buxton seems to think that if this individual payment were done away with, the State could not insure that 'all children receive fair play.' It would be well to have a definition of fair play. Does it mean that each child shall have a like amount of attention? If it does not, then some must suffer; which kind of child is it to be, the dull or the bright? In either case the parent has a right to complain. The smart child, if neglected, is being robbed of his due; and if the dull child is neglected the same thing happens. But that is exactly one of the results of the system of payments now in vogue. The smart child can do his work in six or nine months of the year; he is then often left much to himself, and the teacher's time is devoted wholly to the dull children. Now if the maximum grant could be earned as in class subjects, there would be more inducement to allow the bright children to do the work of the next standard, without fear of loss of grant by partial failure; and the dull child would not need the goad to urge him to reach a stage which his poor brain refuses to aspire to. Mr. Buxton thinks that 'clever children will always receive attention;' a perusal of Mr. Rick's report to the London School Board will awake him from such a dream. And although we are told that each child should have fair play, yet immediately afterwards we are told the 'weakest and most helpless are just the children who ought to be the object of especial care,' and that at the expense of the clever children (p. 45).

Mr. Buxton accuses managers, teachers, and school-boards of overloading the time tables of their classes and schools with specific and class subjects, and says, 'it is their inconsiderate conduct, and not payment by results, which ought to be blamed.' We think that by this sentence Mr. Buxton practically condemns the system of payment by results, as fully as could be done by any words which we could use. If sufficient money to carry on the education of the country is not given, except by putting on extra subjects, who is to blame—the managers or the system? Certainly the system, and under these circumstances it stands condemned. Let the system be a rational system, let the teachers and managers be trusted, let examinations be conducted apart from inspection, and principally by the teacher in the presence of the inspector, let the examination in classes be extended to the 'three R's,' the maximum grant as at present being paid if the passes are considered good, and we shall hear no more about 'grinding tyranny' and 'overpressure'

By implication, Mr. Buxton says that it is more money with less work that is wanted by teachers. Speaking for the great body of teachers we may at once deny the charge. It is not the work which is complained of, but the worry and the degradation, alike to teacher and scholar, of being compelled to *force* a small percentage of children up to the passing point. And here we may as well answer the question whether children leave the school better than they enter it. True, they have a part of the benefits which they should derive from their presence there, but do they leave school with any desire to continue the education they have begun? Let the statistics for evening schools answer. Is it not a lamentable fact that out of 340,000 children (Blue Book, p. 16) leaving the school yearly, before passing through the standards, only 24,434 should be found in night schools?

The fact is as stated to us by the teacher of one of the new recreative classes a few days ago. 'As soon as ever we begin in anything like earnest to teach the "three R's" away they go. They have had so much of it, and have been so disgusted with it in the day schools, that they will now have no more of it.' There are more children and young people readers now than formerly, but to those who have been *forced* to reach the standards reading is a punishment and books are a bore.

Mr. Buxton deals with some of the recent modifications of the system. We wonder whether it did not strike him, when speaking of these, that a system which needed so many relaxations must be inherently wrong? And at the same time, whether these very modifications are not the results of persistent agitation by those whom he accuses so vehemently, and whom he refuses to trust? The age clauses, the re-presentation clauses, the exception schedule, the limitation of the grant for individual examination, for all of which Mr. Buxton has a word of praise, would never have been granted but for the N.U.E.T. Let their views prevail still further in the entire abolition of the system, which has, along with the good it has done, wrought incalculable mischief. But it is only within the last few months that these provisions have been worked anywhere with anything like fairness, and there are numerous districts yet to be found, where the action of H.M. Inspectors practically destroys the effect of the concessions made by the Department. The very large number of cases, quoted from Mr. Fitch's reports, in which the withholding of a small number of children from examination affected the merit grant, proves that it is only perforce that the inspectors will allow its use, and even then they visit the managers with loss of grant. It is absurd to talk of the 153,000 children who were not examined last year (which after all is only some six per cent. of those who ought to have been presented), as being exceptions in the true sense of the term. The reasons for their being withheld were, we venture to say, in 80 per cent. of the cases, due to the impossibility of getting the children present at all, either through sickness, or removal from the neighbourhood of the examined schools. Where were the weak, the delicate, the nervous, the overpressed? *On the schedules and examined!*

Two chapters of the book are devoted to managers and teachers. The former are told of the hundred ways in which they may supplement the efforts of the Department, and provide a safeguard against such evils as are inherent to any misuse of work; the latter are told, again by implication, that they have themselves to blame for the overpressure, by neglecting their work in the earlier part of the year. The teacher is told that his lot is a happier one than that of his Continental brother; and lastly, to rest and be thankful, inasmuch as his pay is better, his work more varied, and less of a drudgery than of yore. And all this while there are nearly 11,000 teachers getting less than 30s. a week! Save the teachers from friends of this stamp. How many of them will agree with him in saying that, 'the Code and its administration are being perfected year by year, and that overpressure, if it exists, must tend to disappear, as the new regulations come to be thoroughly understood and universally applied,' so long as the Code and its administration are based upon present lines?

We have said so much respecting Mr. Buxton's book, that we have little space left for Mr. Sonnenschein's. Like the former, it is a reproduction from a magazine. Starting with Mr. Matthew Arnold's dictum, that popular education should be treated comparatively, he examines the question of overpressure, declares that cram begets a distaste for learning which demoralises the student's whole nature, narrates the various stages of national education in England, and then compares the system with that of Belgium, to the great disadvantage of our own. As a teacher acquainted with the educational codes of nearly every country, he declares that 'payment by results of any kind is a virulent poison, fatal to all honest work.' Especially is he severe on the standards adopted in England. Those who are acquainted with him, will know that the Arithmetic Standards come in, and we think wisely, for his severest condemnation. Need we say that the standards will be bad till we have a radical change in our spelling, and our system of weights, measures and money.

A chapter is added on 'Suggestions for Improvements of the Code,' with most of which we are quite sure our readers, as practical teachers, will agree, although there may be some difference of opinion as to the order, and the magnitude, of the defects of the present Code, as here placed. As we have already said, every teacher should buy a copy of these two publications, in order that they may see themselves as others see both themselves and their work.

A Geography for Primary Schools. By Robert Gumley, Public Schoolmaster, Tasmania. Melbourne: George Robertson and Co.

Educational theorists have at last established beyond dispute the principle that the contact of mind in its early development with a large array of facts, to be accepted on the authority of a text-book, and having no distinct correlation amongst themselves, and less connection with the realm of experienced knowledge, is, to the child-mind, both wearisome in effort and stultifying in effect. This little primer collects within the space of thirty pages:—

(1) FACTS OF GEOGRAPHICAL TERMINOLOGY, without pictorial or diagrammatic illustration, and with no references to the island home of the scholar.

(2) FACTS OF THE CHIEF PHYSICAL FEATURES OF THE WORLD. On the first page of this portion of the book are no less than one hundred and twenty of these geographical facts, collected from every continent, every ocean and sea. We ask ourselves, What must be the effect of crowding into little minds this mass of isolated facts? There are men with remarkable powers for retaining disconnected facts, and so long as the memory maintains its force and quality such men are in request; but let memory become weakened, let the man thus trained become uncertain in his control and reproduction of facts, then distrust of himself is followed quickly by distrust by others. We have recently urged in these columns the arrangement of the facts of physical and descriptive geography in their rational grouping, and trust that in the future text-books of geography will aim at a scientific treatment of the subject.

(3) FACTS CONNECTED WITH THE COUNTRIES OF THE WORLD. These are very brief notes. The facts are carefully selected. Upon turning to Tasmania, it is disappointing to find only a summary fourteen lines in length.

(4) THE FACTS OF PHYSICAL GEOGRAPHY are generally reliable. The following statements need correction in succeeding editions:—

(*a*) By means of the atmosphere the sun's light and heat reach the earth.

(*b*) After sunset the heated air will rise so rapidly that the lower strata of air will freeze, and its moisture will be deposited in the form of FROST.

(*c*) The hot air—being lighter than the cold air—rises, and the cold air rushes in to fill its place and causes wind.

These are serious errors, and mar considerably the collection of physical phenomena which closes the book.

The Stanhope Arithmetical Test-Cards for Boys and Girls. Standards III.—VII. London: Blackie and Son.

This is a very serviceable set of cards, providing two good sets of questions, one on each side of the cards, coloured red and black. The one set is suitable for girls, being somewhat easier than the others, and may therefore be used with great advantage by the more backward boys also. By arranging the sums of one set in a particular order, class teaching or drill in the rules prescribed for each standard may be adopted. So far as we have tested them, the answers may be relied upon as being correct. Two copies of each answer card are enclosed in each packet. We can recommend the cards.

Triple Examination Test-Cards. London: Gilbert and Rivington, Limited, 52, St. John's Square, E.C.

These cards are well printed on both sides, with different coloured boards for each standard, and enclosed along with two copies of answers in a cloth envelope instead of the usual case.

The sums are varied in character, and suitable in every respect. On the reverse side are printed questions in spelling and grammar for Standards II. to IV., and grammar and analysis for Standards V. to VII. It is claimed for the cards that the questions are so arranged as to be a means of both testing and teaching spelling. Our readers will readily see how impossible it is to do this fully when we say that of the fifty two questions on the cards in each of Standards II. and III., one-half are simple exercises in transcription, and the rest such questions as 'Write down as many kinds of food as you can,' 'Make a list of tools used by a shoemaker,' 'Add a syllable to the following words,' and 'Learn the spelling and give the meanings of the following words.' The compiler must be exceptionally well situated if his second standard children can give meanings of such words as *symbol*, *cymbal*, *maize*, *maze*, etc., which form part of one question on card W.

But it is to the excessive requirements in grammar on these cards that we take the most exception. Teachers have complained about the exorbitant demands of the Inspectors, but they cannot be blamed for exceeding the Code requirements if teachers will persist in themselves pressing so much upon their children as the preparation of these cards would intimate that some do. In Standard II. they suppose that the child has ability not only to pick out nouns and verbs, but to tell all about gender and number, among other words these being given—Crisis, oasis, dice, heroine, ally, axis, phenomenon, whey, scissors, bandit, and the children are asked either to make their plurals or say what number they are. Here is a specimen of a question for Standard III.:—'What do you mean by *tense?* How many tenses are there? Give an example of each.' And another:—'Give the various degrees of comparison of these adjectives—Merry, most, prudent, hot, less, first, farther, worst.' Poor Standard IV., however, as in almost every other subject, comes in for the severest handling of all. On each card there is a verse, and under it the first question is 'Parse the words in italics.' This is a specimen:—

'I *flew* to the pleasant *fields*, *traversed so oft*
In *life's* morning *march*, when *my* bosom was young;
I heard my *own mountain* goats *bleating aloft*,
And *knew* the sweet strain *that* the *corn-reapers* sung.'

These words are to be parsed by those from whom a simple sentence only is asked by the Code. The children, too, must know practically the whole of the etymology of the English language to answer the questions fairly, for they are asked such questions as, 'What is a participle? How many participles have verbs?' And the following strange, incomplete question follows the last: 'Why are they called imperfect? What does the potential mood indicate?' In fact, the whole range of grammar is traversed by the questions for this unlucky standard. The other standards are not quite as bad as this, but in many cases in the fifth much more is asked for than the Code requires; and although we think it perfectly fair for a teacher to teach as much as he pleases, and by his own methods, in his own school, he should not raise false ideas of the standard to be attained by publishing tests which go beyond what can reasonably be expected by any Inspector. There is always a danger of making the minimum of requirements the maximum of teaching, a danger greatly aggravated by the system under which teachers labour, but at the same time there is equal danger of making the minimum too high for the weak ones of the school.

Notwithstanding our criticism, we must say that teachers favourably situated, who are enthusiasts in their work, and especially in teaching grammar, may use these cards with advantage. In any case they may take such parts of them as they think suitable and leave the rest.

School Electricity. By J. E. H. Gordon, B.A. Pp. 262. Sampson Low & Co., London, 1886.

Magnetism and Electricity. For the use of Students in Schools and Science Classes. By H. C. Tarn, M.C.P., F.S.Sc. Pp. 184. W. & R. Chambers, London and Edinburgh. 1886.

It is an interesting and instructive sign of the times that two such books as the above, professing to explain to schoolboys a science which as yet has been chiefly the

property of specialists and technical men, should simultaneously appear. Some attempt, indeed, to raise the standard of knowledge of this and kindred branches of the Theory of Energy was surely necessary, in the face of the ridiculous misconceptions and childish errors into which even the best newspapers almost constantly fall in the leading articles in which they exult over any new discovery. We have seen, for example, in a journal which professes to enlighten some hundreds of thousands of our fellow-men, a hope expressed that some time in the not far-distant future, that same ingenuity which lights the Pullman Cars of the Brighton Railway by electricity, which the train's own motion generates, may be applied to devise means by which the motion may generate electricity enough not only to illuminate, but to drive the train!

Mr. Gordon's book being the exact opposite of Mr. Tarn's, to review the one will be to review the deficiencies of the other. Mr. Gordon's is in every sense of the word original, a quality that can in no sense be claimed for Mr. Tarn's, which in truth is about ten years out of date. Our main quarrel with it is that it should be called a 'School Electricity,' for to our mind it is much too difficult for school purposes, and there are few professed scientists that would not find a great deal in it that was new to them. It commences, practically, with Ohm's Law and a statement of the action of currents on magnets. It has always seemed to us that this action is much more clearly understood by the phrase 'right-handed screw' than by the elaborate diagrams of swimmers (in full bathing costume) with which Mr. Gordon supplies us. The meaning of a 'right-handed screw' once shown is never forgotten, and Œrsted's Law can then be concisely stated. 'The lines of force due to a current screw right-handedly round it,' and the laws of the direction of Electro-magnetic Induction admit of similarly simple statement, even to novices. The units are then explained, especial prominence being rightly given to the unit of work and to the commercial units. The various batteries are explained, and a slight account of dynamos is given, their full description being (as we think, needlessly) deferred to eleven chapters later. Then come details of various galvanometers, and separate chapters are devoted to the measure of E.M.F. and Resistance. The practical application of the science to Telegraphy, Telephones and Microphones, and to Electric Bells, receive a chapter each, while twenty-seven pages is given to the theory of electric lighting. Under the head of Telegraphy, we think that the duplex, if not the quadruplex method, is at least deserving of a mention. 'Diamagnetism and Magne-Crystallic Action' is one of the best chapters in the book; indeed, one of the best chapters on its subject in any English elementary book. It is followed by an account of Ruhmkorff's coil (though for some reason it is not called by its inventor's name), which suffers from condensation, and compares very unfavourably with the account given, for instance, in Professor Sylvanus Thompson's excellent 'Elementary Lessons.' To make this apparatus clear, we think that a diagram giving a longitudinal axial section is necessary. More than thirty extremely interesting pages are then given to the remarkable phenomena investigated by Crookes, Spottiswoode, and Moulton (for surely the last-named physicist deserves the mention which Mr. Gordon refuses him), and a great deal of light is thrown upon the ultimate constitution of matter, though, if our author expects the average schoolboy to follow him into the Kinetic Theory of Gases, and to understand him when he talks of 'the mean free path of a molecule,' he expects even more of that victim of overpressure than Lord Macaulay did. Not before the two-hundredth page is the subject of electrostatics introduced, and in this change, as in every other, Mr. Gordon shows to immense advantage, for no evil has been wrought to the science which is approximately comparable with that done by the two adjectives 'Frictional' and 'Voltaic' when applied to the term 'Electricity,' leading the student, as it inevitably does, to infer an essential difference between the two kinds of electricity considered. Two weighty reasons are in favour of the change of treatment which Mr. Gordon adopts, the first that Statics is necessarily a particular case of Dynamics; the second, that so-called 'frictional phenomena' are altogether unimportant, and except in the theory of atmospheric electricity do not at all bear on practical life. Twenty-five pages is amply sufficient for treating 'electrostatic induction,' and our author is particularly successful in explaining the Faraday-Maxwell theory of 'action in the medium.' Chapter xxvi. contains an account of Professor Bjerknes' experiments on pulsating spheres—very interesting, but quite out of place in a 'School Electricity.' The last two chapters contain an account of the correlation of Magnetism and Light, and of the Electro-magnetic Theory of Light. This last theory is not, we think, quite so lucidly treated as it might have been—as it is, for example, in Daniell's 'Text-Book of Physics.' Finally, ten examination papers and an exhaustive index are provided.

To sum up; the book is excellent, and we should be sorry to see a word of it omitted, except (will the author pardon us?) occasionally the name 'Gordon'; but we scarcely think that true proportions of importance are observed, we should have liked some reference to atmospheric electricity and to terrestrial magnetism as probably an induction phenomena, and we submit that the title is utterly inappropriate. We should recommend every schoolmaster of our acquaintance to purchase the book—for his own edification, not his pupils'.

Mr. Tarn's book may be much more briefly considered. He follows the vicious lead of South Kensington, for whose Science and Art Examinations he expressly lays himself out. There is touching pathos in the moral aphorism with which the book closes:—'A thorough knowledge of what this little book contains will be a safe passport to a *first-class* in any *elementary paper*' (the italics are our author's) 'in the *Department*. A *love of study* grows with the *acquirement of knowledge*, but there is no satisfaction in having a *superficial acquaintance* with any subject.' Of its kind, the book is good enough, very neatly got up, and with an admirable arrangement of blacker letters to indicate important catch-words, as we have illustrated by italics in the example above. Messrs. Chambers have done their work three or four times better than Mr. Gordon's publisher, and our entire complaint is of matter, not of manner. The day of proof-planes, and ice-pails, and butterfly-nets, of magnetisation 'by single and double touch,' of 'frictional electricity' generally, has, we think, passed, except for the mathematicians; and to write a book, of which seventy-two pages are devoted to 'Frictional Electricity,' and only fifty-two to 'Voltaic Electricity,' and the remainder to Magnetism is, we humbly submit, to retard rather than to advance science.

We do not like to quit it thus. If the South Kensington authorities must, perforce, lay stress on the unimportant, the South Kensington examinees must, we suppose, be provided for, and this could not well be better done than by this book. We only hope that when the London University makes Electricity one of its subjects for matriculation, according to the proposal now before Convocation, it will be on the lines of Mr. Gordon's book, rather than in the track of South Kensington.

The English Language and Literature. London: Messrs. Blackie and Son.

This is one of Messrs. Blackie's elementary text-books, and considering its cheapness and value, it ought to command a very large sale.

Of its sixty-four pages, fifty-four are devoted to the History of the English Vocabulary, the Grammar and Growth of the English Language, and Derivation of Words. Five are devoted to Prosody, Metre, and Examination Questions, and the remaining four or five to an Outline of English Literature. Under these circumstances we cannot help thinking it a pity that the

word 'literature' appears at all on the title-page, and that the subject was attempted at all. The space thus saved could be most valuably used for more Examination Questions, and even entire papers as actually set by the different examining bodies.

The preface assures us that the work 'fully meets the requirements of the Code regarding the English Language as a special subject in elementary schools, and as prescribed for pupil teachers,' and to this we cordially assent.

The different elements of the language are carefully traced back to their respective origins, and any pupil after mastering the little work ought to be able to tell from what source all the words in a sentence spring. There are two or three small maps showing the original seat of the English, and the Norsemen's descents, etc., etc. We are a little surprised to find nothing—at least, if it be in the book we have missed it—said about the reason for the retention of the 'u' in such words as 'colour,' for which we contend with Americans, and its absence in orator.

The few pages on prosody contain a good deal of information.

On the whole we heartily recommend the volume for its cheapness and perspicuity of arrangement.

Latin Vocabularies for Repetition. By A. M. M. Stedman. London: George Bell and Sons.

We cannot help thinking that this little book will be found very valuable by those studying Latin, and especially by those preparing for a scholarship examination at the public schools.

Little boys are, in those examinations, not expected to have seen any of the passages set for translation before, and their great difficulty generally occurs in their lack of knowledge of words. This, this work ought to supply.

Mr. Stedman has arranged these vocabularies according to their subjects; each vocabulary consisting of twelve words, of which the last two or three are verbs, and the rest nouns, both substantive and adjective. They are printed in three columns, the first being the Latin words, the second the genitives or perfects and supines, and the third the English. We cannot help thinking it a great pity Mr. Stedman did not add a fourth column, of English derivatives. Nothing impresses a word on a boy's mind so much as a derivative, especially if it is slightly changed in form, *e.g.*, if a boy had to connect 'portent' with 'portendere,' 'to foretell,' he would be less likely to forget it. He is not unlikely to have come across 'portent' in one of his story-books, but not so likely to have come across 'portendo.' Then again the English derivative from a verb often gives the supine, and that from a noun the root of the oblique cases.

The author has, wisely or unwisely, omitted all common or generally known words, *e.g.*, though there are no less than six vocabularies with regard to parts of the body, of which no fewer than forty-five out of the seventy-two words are substantives, the words corpus, caput, manus, pes (except in connection with a verb), oculus, and others do not appear. Considering there are no less than 213 of these lists of twelve words, if a boy has them pretty well at command, he has probably nearly as large a vocabulary of Latin words in his mind as English.

We believe the book could be very considerably improved, but in its present form it would be found eminently useful for all preparing for examinations, and to such we heartily recommend it.

Notabilia of Greek Syntax. By Rev. F. Wilkins Aveling, M.A., B.Sc. Relfe Brothers.

We have here a great deal of Greek syntax, very carefully and clearly arranged. The Article is well discussed, showing the meaning of its absence, its presence, and its position.

The prepositions are printed the wrong way of the book in three columns, the meaning of the prepositions with the genitive being in the first column, with the dative in the second, and with the accusative in the third. We first have those prepositions discussed which are only found with one case; next those found with two; and, lastly, those found with all three. These half-dozen passages are perhaps the most valuable of the book. The forces of the oblique cases are thoroughly well analysed, and the dative is shown to be the exact opposite of the genitive. Thus, whereas the genitive expresses (*a*) separation, (*b*) partition, (*c*) relation, the dative expresses (*a*) proximity, (*b*) addition, and (*c*) equality, not comparison. Now we maintain that this kind of teaching raises grammar from being, what it used to be, a very little more than a tax on the memory, to a valuable mental exercise, and as such highly educational. There are teachers, no doubt, who think that the Latin and Greek grammars, syntax and all, ought to be learnt by very small boys, and that they ought to be discouraged rather than encouraged in asking questions as to why this is this, or that is that. We very much suspect that such teachers are somewhat afraid of being puzzled, and do not care to stand confessed as not knowing.

In the chapter on the verb the student will find some terms which may be new to him, such as 'gnomic' or 'iterative'; but their meaning is well implied in the examples brought forward.

At the end of the little volume we noticed some valuable remarks on οὐ and μή, taken separately and together.

The book reminds us somewhat of a most valuable little work published at Cambridge a few years ago, in which the Latin and Greek languages were treated side by side, very much as the author in this work has treated the Greek, and we cannot help thinking he might have assisted the learner if he had made some references to the Latin and the modifications they made of the older language.

As You Like It. By Shakespeare, with Explanatory Notes. Blackie and Son.

This is another of Messrs. Blackie's well-known school classics, and is done with the usual care and liberality that all such works emanating from their house always receive.

There is a two-page biographical notice of Shakespeare, and an introduction as to the date of the play, its source, and its scene. The notes being at the end of the book, it can be used as a class-book.

These notes are chiefly as to the meaning of words and expressions. We cannot help thinking that many students want more help in the syntax and scanning of Shakespeare than the majority of commentators give.

A Text-Book of Book-Keeping. Parts I. and II. By J. J. Doherty, LL.D., T.C.D. Dublin: A. Thom. London: Simpkin and Co.

Dr. Doherty has divided his work into two parts, the former of which is short and simple.

The author is evidently fond of the subject, and has brought a good deal of teaching power to bear upon it. He ventures to assert in his preface that book-keeping 'is fully equal to any other of the sciences as a means of intellectual discipline,' adding that 'in its study pupils are constantly called upon to apply the principles of the commercial rules of arithmetic to examples of business transactions. It affords practice of the best kind in penmanship. It encourages habits of neatness and of accuracy, which are of essential importance to the student, whatever his future occupation may be.'

With some of this we cannot agree. Most examiners know that it is generally a very deficient lad who gets the writing prize, and of all arithmetical operations none are more mechanical and less educational than those which are connected with book-keeping. That certain operations in book-keeping require a good deal of thought we readily admit, but to name it as an educational subject, equal to natural science, we think wrong.

Dr. Doherty promises teachers that if they will use his

book as directed, the science shall 'not prove the dry, repulsive, complicated subject it is usually regarded by students,' and we can well believe that his promise would be fulfilled, for, doubtless, his explanations are very thorough and simple, and the exercises short and interesting. In fact, the shortness of the exercises is, to our mind, one of the most striking features of the first part. An exercise could be easily begun and completely balanced at a single sitting.

The work begins with such simple accounts as a farmer's week's payments and receipts, which are only to be taken from the waste-book into a petty cash account. Then there are gradually introduced ledger cash accounts, personal accounts, real accounts, etc., until we arrive at the more difficult subject of fictitious accounts. Journalising and double entry have received due attention, even in the first part.

In the second part, which is a volume of 200 pages, we have the more elaborate transactions of business fully entered into, and each of the six chapters are supplemented by a large collection of examples and examination papers as actually set by the Civil Service Commissioners and others. There are answers to all the questions, some fuller than others, with references to the paragraphs of the work where the explanations asked for will be found.

In conclusion, we have no hesitation in saying that the book ought to be in the hands of every teacher of book-keeping, in spite of our disagreement with the author as to the high place he would assign to book-keeping as an educational subject.

How to Teach the Babies.

BY JAMES BAILEY,

Head Master of the Southlands Training College.

FIRST, Who, and What, are the babies? The first consideration, preliminary to *teaching* the babies, must surely be one which has reference to the nature of the babies to be taught. It is clear that no satisfactory treatment of anything whatever can be ensured unless we know the kind of material with which we deal. This is not peculiar to teaching, but is equally true of all human efforts. If we are ignorant, or, if knowing, we are heedless, of the nature and capacities of what we work upon, we shall certainly commit grave errors, expend fruitlessly much energy, and expend hurtfully a good deal more; and the possible harm done will be proportionate to the value and the preciousness of the material thus wrought upon.

This consideration opens to us a fruitful cause of much error and mischief in the past treatment of children. High aims, well-intentioned effort, conscientious discharge of duty, unsparing labour, have been misdirected, and their issues have proved disappointing and unsatisfactory in a high degree, because of not knowing or of ignoring the limits of a little child's capacity and power. We do well, then, at the threshold of our work, to pause awhile before entering on it, in order to acquaint ourselves as we best may with the nature and capacities of a little child.

Now, who are the babies whom we have to teach? The scope of our inquiry is, of course, limited to those youngest children of the infants' school, constituting what is usually known as the babies' class. I wish to draw a distinction between the babies of an infant school and those children in it who can hardly be so classed. By Art. 13 of the New Code (1885), 'No attendance is, as a rule, recognised in a day-school for any scholar under *three years* old,' an age young enough, surely, for a child to be taken from home and its surroundings, and to be placed under the care of a stranger, and subjected to any kind of routine and of discipline, however wisely and kindly it may be administered. Yet, as a matter of fact, thousands of children below three years of age find their way day by day into the day-schools of England and Wales. In the Report of the Committee of Council on Education for 1884-85, I find that of children *between the ages of two and three years*, the estimated number usually found in elementary schools is 618,469, of whom more than 10,000 were entered 'on the registers of annual-grant schools,' the rest being presumably in private-adventure schools of various kinds. But, of course, a child does not cease to be a baby, in our conventional and practical sense of the word, when it reaches the age of three years. The special treatment proper to the *baby class* reaches much beyond this. From the source already quoted, we learn that the number of children attending schools who were between three and four years of age was estimated at 598,505, of whom more than 124,000 were in 'annual-grant schools,' while the numbers of those between four and five years were respectively 597,059 and 286,346.

Now, it is not too much to say that if every home were what it should be, a very large proportion of these children would be better kept from school till a considerably later period of life. School-life for children so young can only be justified by the most carefully adapted arrangements and processes, both of instruction and of discipline. Happily, such conditions are not inaccessible, if too rare. The social conditions of a very large proportion of our population make it in the highest degree necessary and expedient to provide school accommodation and proper school-work for a very large number of children, at the earliest possible age at which they can be rightly managed. The usually accepted limit of infant-school age is from three to seven years, but, as we have seen, many thousands of children below that limit have to be dealt with. One of the first requisites of school organisation is that of grouping the children into classes, and in an infant school the mode adopted must be, to a great extent, a classification according to age. It is scarcely necessary, perhaps, to adopt the rigid mechanical lines forced, or said to be forced, on the teachers in many large infant schools by the exigencies of preparing for the special modes of examination adopted at the annual visit of H.M. Inspector, by which the classes of children are known as 'the sevens,' 'the sixes,' 'the fives,' etc. A natural and reasonable classification seems to be that of three groups: the upper, comprising all above six years of age; the lower, those below four and a-half, or thereabouts; the middle division, all the children between these groups. It will be obvious that no exact age limit should be rigidly insisted upon in any school, least of all in an infant school. One child of four, or of five, years old will often be found very much in advance of others of similar age, both as to bodily strength and development, and to mental vigour; while others fall as much below the average. Our babies, then, we will take to be the youngest children of an infant school, being those who range from the earliest age at which they are admitted to those of, say, four to four and a-half years old. Now, what sort of being is such a child? He enters school feeble in body, immature, of course, in mind, with a delicate and highly susceptible organisation—in body, quickly and easily

affected by conditions of light, temperature, and physical surroundings generally; in mind, easily moved to fear, joy, emotion of any sort; so delicate in nervous structure as to be impressionable by very slight causes, incapable of bearing any continuous strain, physical or mental. Such a child is a creature essentially of impulse. Its mental life is almost exclusively one of emotion. The feelings, affections, and moral emotions are active at that early stage of development, in a degree far beyond that of the intellect. *Desires* are manifest with a strength of will, necessarily unchecked and unregulated by a knowledge of what is right, or by power of self-control. As already remarked, his fittest training would be that of a good home; his fittest teachers, were all things favourable, the parents, brothers, and sisters, and the home circle generally—for such a little child needs the genial sympathy and kindly influences of home to support him, and in which to develop.

It is, therefore, clear that under such circumstances the school conditions of a young child's life should have much in common with the home conditions proper to him. There must be something of the same considerate treatment which the affectionate relations of home should naturally induce.

Again, the muscular system is so weak that he can neither sit nor stand, nor walk, nor remain in any one position, for more than a very short time, without being subjected to discomfort and to risk of injury. Yet even this early stage of development is, when the body is healthy and its wants fairly supplied, one of almost incessant activity. The mind, in waking hours, is vigorously engaged in unceasing observation of all that surrounds it. This mental observation is carried on entirely through the *organs of sense*. The forms and colours, the motions and distances, of all things visible are, through the eye, making their impressions upon the mind: the varieties of sound from inanimate and animate surroundings, from the rushing of the wind, the pattering of the rain, the shriek of the railway engine, the song of the birds—above all, the tones and speech of the human voice—are entering through the ear and leaving their trace on the active intelligence within. Objects within reach are felt and handled, and, through the subtle sense of touch, the many messages are similarly conveyed from them, of the qualities of weight, density, mobility, smoothness, softness, roughness, hardness, and the like. The child is thus ever learning, ever adding to the store of ideas of which its knowledge is gradually built up.

And this multitude of impressions thus borne in from the world without, through the medium of these and the other bodily senses, are all transmitted in some mysterious way to the mind through the agency of the child's brain. Now, it must be distinctly borne in mind that the brain, being a physical organ, as distinctly as is the eye or the hand, is subject to like weariness with them; it can only perform a very limited amount of work without the need of rest, and especially requires the very frequent relaxation of a change in the direction and kind of strain to which it is exposed.

Once again, not only must regard be had, in the treatment of young children, to their physical necessities, their mental constitution, and their craving for active and suitable exercise, but also to that other condition of child life, sometimes spoken of as 'the law of happiness.' It is, indeed, a most beneficent provision that no condition or environment of his life can permanently interfere with this law, *i.e.*, when free from pain and with bodily needs reasonably supplied. Whether its surroundings be those pertaining to the squalid home of abject poverty, its playground the court and the gutters, with mud and sticks and street refuse for toys, or the luxurious resources of a wealthy home and a well-appointed nursery, the result in this respect is much the same—the little child, left to himself, will extract the materials of happiness from the things around him. And the child brings with it to the school the same happy faculty of facile adaptation to its new circumstances, and, when the first feeling of shyness, or, possibly, the first storm of passion, is over, it responds readily to the sympathetic advances of its schoolfellows, and the reasonable requirements of a kind and wise teacher.

And now our inquiry must be, Is there in any fair measure the fulfilled requirements of infant-school treatment for such a nature as we have been considering? Are the requisite conditions satisfied in any reasonable degree, and to any considerable extent? If as yet such schools are too rare, it may at least be said that there are enough of them to make it manifest that it is not because of insuperable difficulty in providing them.

Our next paper must deal with the kind of school, and the kind of teacher whom the babies need.

(To be continued.)

—o—

Pupil Teachers' Prize Competition.

With a view of affording help to those of our subscribers who are preparing for the Pupil Teachers' Examination next month, we give a complete set of questions for practice. They are based on the requirements laid down in Schedule V. of the Education Code, interpreted in the light of recent examinations. The arrangement adopted in the Government papers of last year has been followed, and all the instructions have been given, so as to make competitors familiar with the details of the examination.

Working a set of papers through will form a very useful preliminary exercise in view of the work of next month. It will impart the confidence which springs from practice; it will reveal possible weak points which may need special further attention; it will enable examinees the better to economise their time in writing their answers to the Government examination questions.

To encourage pupil-teachers to make this use of the following papers, we propose to give eight prizes of half-a-guinea each, namely, two for the best sets of answers sent up by pupil-teachers of each year, one for male pupil-teachers, and one for females. The following are the conditions of the competition:—

1. Each competitor must be a subscriber to the Practical Teacher.

2. All answers must be the *bonâ-fide* work of the candidates sending them in, without help from

books. A certificate to this effect, signed by the teacher, minister, parent, or guardian of the candidate, must be sent with every set of answers.

3. Each competitor must choose a pseudonym, which must be written on each separate sheet of paper, containing his or her answers.

4. The real name of each competitor must be sent in a separate letter with the pseudonym. These letters will not be opened till the papers are examined and the awards made.

5. Answers are to be written on *one side* of the paper only.

6. All sets of answers must be sent not later than March 12th.

The awards of the examiner, and answers of the Prize Winners, will be published in the April number, on the appearance of which the prizes will be forwarded.

THE 'PRACTICAL TEACHER'

Prize Competition for Pupil Teachers.

Examination Papers.

FIRST YEAR.

Three hours and a half allowed.

Arithmetic.

MALES.

1. Find the shortest length of rope which can be exactly measured by each of the four measures, 3 ft., 3½ ft., 5 ft., and 4 ft. 7 inches long respectively.
2. From ⅘ of a ton subtract 2¾ cwts. and express the remainder as a decimal of a ton.
3. Two-thirds of an estate is left to A, and two-sevenths to B. The remainder falling to C is worth £506. What is the value of A's share, and of C's?
4. Divide ·079 by 7·39 and express the answer as a decimal.

FEMALES.

1. Make a bill for the following, and show how it should be receipted when paid:—

59	yards silk	at	4s. 7d. per yard.
27	„ calico	„	6½d. „
83	„ ribbon	„	1s. 3d. „
15¾	doz. buttons	„	4s. 3d. per dozen.
4½	yards velvet	„	12s. 9d. per yard.

2. Find, by practice, the value of 3115 ounces of plate at 13s. 9½d. per ounce.
3. What would be the rent of a farm containing 53 acres 3 roods 10 perches at £3 7s. 8d. per acre?
4. What numbers less than a 1000 can be exactly divided by each of the integral numbers less than 8?

Grammar.

MALES AND FEMALES.

1. Parse and analyse:
'Thrice is he armed that hath his quarrel just.'
2. Distinguish between the various uses of the form made by adding *ing* to the verb.
3. Give as complete a classification of adjectives as you can, and explain it.

Geography.

(Answer two Questions, and draw one Map.)

1. Draw a map of one of the following:—
(*a*) The east coast of Scotland.
(*b*) The Dominion of Canada.
(*c*) Australia, with its various divisions.
2. Mention the different mining industries of Great Britain, specify the districts in which each is carried on, and give a full account of one of the most important.
3. Compare the geographical features of Wales with those of East Anglia, the eastern counties of England.
4. Write an account of the commerce between Great Britain and British North America.

History.

1. What were the most striking incidents in the Roman Conquest of Britain, and what were the more important of its permanent results?
2. Narrate briefly the events that led to the establishment of several Saxon kingdoms in South Britain, and their ultimate union into one.
3. Write an account of the reign of Alfred or of Edward the Confessor.

Composition.

Read carefully the following passage, and then write it from memory:—

In 1504 Columbus effected a landing on Jamaica, where he wished to found a colony. The islanders kept far from the shore, and allowed the Spaniards to suffer want of provisions. A curious stratagem was employed in this time of need. Columbus, knowing that a lunar eclipse was about to happen, had the chiefs informed that he had important matters to communicate to them. He then reproached them in strong terms for their unkindness, and told them that they would soon be severely punished for it. 'The God of the Spaniards,' he added, 'will strike you one of His most terrible blows. In proof of which, this very night the moon will grow red, and then hide herself and refuse her light; and this will be only the beginning of your misfortunes unless you profit by what I have said to you.' A few hours later the eclipse began. The terror-stricken savages threw themselves at the feet of Columbus, and swore they would not let him want for anything. The clever seaman listens to their entreaties, and after withdrawing for a short time, he announces the re-appearance of the moon.

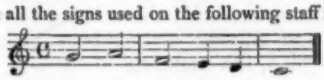
Music.

OLD NOTATION.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*.)

1. Name all the signs used on the following staff:—



2. Write the above phrase an octave lower on the bass staff, giving each note half its value.
3. Give the position of the minor seconds in the scale of C (Do) in both the treble and bass clef.

TONIC SOL-FA NOTATION.

1. In what measure is the following:—

| m : — | f : — | r : t_1 | l_1 : t_1 | d : — | — : — ‖

2. Arrange the notes in question 1 in three measures of six-pulse time, lengthening the notes where necessary.
3. Between what notes of the scale do minor seconds occur, also major thirds?

SECOND YEAR.

Pupil Teachers at end of Second Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

1. Upon the same base and on the same side of it there cannot be two triangles which have their sides terminated in one extremity of the base equal to one another, and likewise their sides terminated in the other extremity of the base equal to one another.
2. Any two sides of a triangle are greater than the third side.
3. Describe an isosceles triangle with each of the equal sides double of the base.

Arithmetic.

FEMALES.

1. Convert into decimals $\frac{41}{500}$, $\frac{313}{1000}$, $\frac{4993}{10000}$, and $\frac{3\frac{1}{2}}{19\frac{1}{2}}$.

2. Simplify $\left\{\frac{1}{2} \text{ of } 3\frac{4}{11} \text{ of } 6\frac{9}{11} - \frac{3\frac{1}{2}}{1\frac{3}{5}}\right\} \div \frac{6\frac{1}{4} + 5\frac{5}{8}}{9\frac{3}{7} - 5\frac{1}{8}}$

3. Out of a £5 note I spend $\frac{4}{15}$, $\frac{7}{12}$, and ·01 ; express the remainder as the decimal of £1.

4. Two-fifths of a farm is sown with wheat, two-sevenths with oats, and the remainder, 35 acres 3 roods, is pasture. What is the extent of the farm?

Grammar.

MALES AND FEMALES.

1. 'The *very law which* moulds a tear,
And *bids it trickle* from its source—
That *law preserves* the *earth* a *sphere*,
And *guides* the planets in *their* course.'

Paraphrase this passage, analyse it, and parse the words printed in italics.

2. Give the meaning of the Latin prefixes *ad*, *con*, *ex*, *in*, and *sub*, and illustrate by examples how each of them may take different forms.

3. What affixes are used in the formation of adjectives of Latin origin? Give examples.

Geography.

(*Answer two questions and draw one map.*)

1. Draw a map of one of the following :—
(*a*) The basin of the Rhine.
(*b*) The North Sea.
(*c*) Spain and Portugal.

2. What are our chief imports from the peninsular countries of Europe?

3. Describe the chief physical features of India.

4. Explain the meaning of Latitude and Longitude, and show in what way correct knowledge about them is practically useful.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

(*One hour allowed for the exercises in Needlework.*)

Arithmetic.

MALES.

1. Find the simple interest on £535 16s. 8d. at $2\frac{1}{2}$ per cent. per annum for $4\frac{1}{2}$ years.

2. If a man has £10,500 invested at $4\frac{1}{2}$ per cent. per annum, what will the income tax on his dividend amount to at 8d. in the pound?

3. At what rate per cent., simple interest, would £1,350 amount to £1,621 13s. 9d. in $5\frac{3}{4}$ years?

4. A person selling a house for £540 gained 4 per cent. on what he gave for it. The person from whom he bought it lost 4 per cent. on what it had cost him. What was the cost to the latter?

History.

MALES AND FEMALES.

1. Write some account of the most important events of the reign of John.

2. Give a summary of the principal incidents in the wars carried on by the Plantagenet kings against Ireland, Wales, and Scotland.

3. What important features characterise the condition of England under the Government of Queen Elizabeth?

Teaching.

Describe the various means you would adopt to ensure good spelling in a class. How would you test spelling?

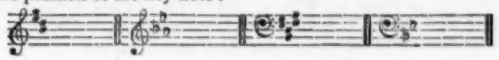
Music.

OLD NOTATION.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*.)

1. Below each of the following key-signatures place the name of the key-note; and in the space after each, place a minim in the position of the key-note :—



2. Place below each of the following intervals its name :—

3. Write two measures of $\frac{3}{4}$ time, using crotchets and quavers.

TONIC SOL-FA NOTATION.

1. Write the names of the following intervals :—*me* to *lah*, *soh* to *te*, *ray* to *fah*, *te* to *doh*^{1}.

2. Write two measures of three-pulse time, with one-pulse and two-pulse tones.

3. How would you describe the mental effect of *soh*, of *lah*, and of *te* in slow time?

THIRD YEAR.

Pupil Teachers at end of Third Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

(All generally understood abbreviations for *words* may be used, but not symbols of operation, such as +, −, ×.)

Answer two Questions, including No. 3, if you can.

1. If a side of any triangle be produced the exterior angle is equal to the two interior and opposite angles, and the three interior angles of every triangle are together equal to two right angles.

2. If a parallelogram and a triangle be upon the same base and between the same parallels, the parallelogram is double of the triangle.

3. From E and F the central points of two parallel sides of a parallelogram, ABCD, straight lines are drawn to the opposite angles, B, D, respectively. Prove that EBFD is a parallelogram half the size of the given parallelogram.

Algebra.

Answer two Questions.

1. Find the G. C. M. of $8ax^4+18ax^3+4ax^2-4ax-8a$, and $9x^3y+15x^2y-3xy+6y$.

2. Find the continued product of
$\frac{x^2-2x+2}{x^2+2x-3}$, $\frac{x^2-9}{x^2+4}$, $\frac{x^2+2x+2}{x^2-2x+3}$, and $(x-1)^2$.

3. Solve the equations :—
(1) $\frac{2x-5\frac{1}{2}}{7}+\frac{\frac{3}{4}x+4}{2\frac{1}{2}}=\frac{\frac{3}{4}x-\frac{3}{4}}{\frac{1}{2}-\frac{2}{3}}$
(2) $\frac{x}{a}+\frac{x}{b}=\frac{1}{a^2b}+\frac{1}{ab^2}$.

Mensuration.

Answer one Question.

1. State and prove the rule for finding the area of a triangle when the base and height are given.
What is the area of a triangular field, one side of which measures 2720 links, and the perpendicular on that side from the opposite angle 1280 links?

2. A rectangular plot measures 72 yards by 96 yards Half the area is occupied by a rectangular pond in the centre. Of what uniform width must the surrounding portion be?

Arithmetic.

FEMALES.

1. If the rent of 19 acres 3 roods is £96 15s. 6d., what will be the rent of 29 acres 3 roods 16 perches?

2. Divide (·379 + ·0165 − ·042) by ·c8484.

3. Find the value of $1\cdot571428$ of $18\cdot2 \times \frac{1\frac{1}{10}\frac{3}{5} + 2\frac{1}{7}\frac{3}{5}}{1\frac{5}{12} - \frac{1}{4}\frac{1}{2}}$ of ·857142 of 12½ guineas.

4. One man could finish a piece of work in 13½ days. He works at it alone for 6 days, and is then joined by another. After working together for 3 days the work is finished. In how many days could the second man have done it alone?

Grammar.

1. 'By this heavy discharge, *which continued as thick* and sharp *as hail, while, notwithstanding* every arrow had its individual aim, *they* flew by *scores together* against each embrasure and opening in the parapet, as well as at every window where a defender *either* occasionally *had past* or might be suspected to be stationed—by this sustained *discharge* two or three of the garrison *were slain*, and several *others wounded*.'

Paraphrase this passage.

2. Analyse the above passage into its constituent sentences, and describe the relations of each.

3. Parse the words printed in italics.

4. Select the words of Latin origin from the above passage, and state by what characteristics you make the selection.

Geography.

Answer two Questions and draw one Map.

1. Draw a map of one of the following:—
   (*a*) Further India.
   (*b*) Egypt and the Red Sea.
   (*c*) Africa, south of the Equator, including Madagascar.

2. Describe, with a reasonable amount of detail, a journey up one of the great rivers of Africa to the interior of the continent.

3. Describe the physical features of Central Asia.

4. Explain how winds are caused, and show why permanent winds prevail in some parts of the earth, while in others they are variable or periodical.

SECOND PAPER.

Two hours and a half allowed.

Needlework.

FEMALES.

(One hour allowed for the exercises *in Needlework*.)

Arithmetic.

MALES.

1. Extract the square root of 6·249; give the answer as a decimal.

2. If I sell £5000 out of the 3 per cents. when they are at 84, and invest the proceeds in 4 per cents. at 96, how is my income affected?

3. Divide £594 in proportion to the products 3×7, $4\frac{1}{2} \times 4\frac{1}{4}$, $22 \times \frac{1}{11}$.

4. The difference between the simple interest and true discount on a certain sum in one year at 4 per cent. is £2. What is the sum?

History.

MALES AND FEMALES.

1. What led to the Civil War? Relate the principal incidents in the course of the war.

2. What events are associated with the following places?—Sedgemoor, Glencoe, Preston Pans, Londonderry, Plassey, Sebastopol, Cawnpore, Navarino, Quebec.

3. State briefly the circumstances under which our American colonies came into British possession, and also those under which a large portion was lost.

Teaching.

Write notes of a lesson on Iron and its uses, or on Money.

Music.

OLD NOTATION.

A quarter of an hour allowed for this paper.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*.)

1. Write the names of the following intervals:—

2. Write two measures of ¾ time, introducing crotchets, quavers, dotted notes, and a rest.

3. What do the following signs indicate?—*pp.*, *ff*, *cres*, *dim.*, *staccato*.

TONIC SOL-FA.

1. Write separately above the note *fah*, a minor sixth, a minor third, a major fifth, and a minor seventh.

2. What do the following signs indicate?—*pp*, *ff.*, *cres.*, *dim.*, *staccato*.

3. Write three measures of three-pulse measure, introducing one-pulse, two-pulse, half pulse, and one-and-a-half-pulse-tones, and a rest.

FOURTH YEAR.

Pupil Teachers at end of Fourth Year.

FIRST PAPER.

Three hours and a half allowed.

Euclid.

MALES.

[The only abbreviation admitted for 'the square on AB' is 'sq. on AB,' and for 'the rectangle contained by AB and CD,' 'rect. AB, CD.' All generally understood abbreviations for *words* may be used, but not symbols of operation, such as +, −, ×.]

(*Answer two Questions, including No. 3, if you can.*)

1. If a straight line be divided into any two parts, the rectangles contained by the whole and each of the parts are together equal to the square on the whole line.

2. If a straight line be divided into two equal, and also into two unequal parts, the squares on the two unequal parts are together double of the square on half the line and of the square on the line between the points of section.

3. The squares on the diagonals of a parallelogram are together equal to the squares on the four sides.

Algebra.

(*Answer two Questions, including Question 2, if you can.*)

1. Find the value of $\left(\frac{2x-a}{2x-b}\right)^2 - \left(\frac{a-x}{b-x}\right)$, when $x = \frac{ab}{a+b}$.

2. If $\frac{a}{b} = \frac{c}{d}$, prove that $\frac{a^2-b^2}{c^2-d^2} = \frac{ab}{cd}$.

3. Solve the equations:
   (1) $\frac{10x}{3} + \frac{2y}{15} = 14$, $\frac{27x}{3} - \frac{y}{6} = \frac{57}{2}$.
   (2) $x^2 - 25x + 161 = 11$.
   (3) $\frac{x-1}{\sqrt{x-1}} = x + \frac{5}{4}$.

Mensuration.

(*Answer one Question.*)

1. The side of a hexagon measures 3 feet, find its area to the hundredth of a square inch.

2. A room has two of its sides parallel, one measuring 17 ft. 6 in., and the other 12 ft. 8 in., 16 widths of plank, averaging 9 inches wide and laid parallel to the parallel sides, form its floor. How many square feet does the floor contain?

Arithmetic.

FEMALES.

1. In what time will £950 amount to £1199 7s. 6d. at 5½ per cent. per annum simple interest?

2. Find the difference between simple interest and true discount on £1365 for 9 months at 4 per cent. per annum.

3. Two towns are 10 miles apart. From each of them a person starts at noon to walk to the other. One person takes 5 paces while the other takes 6, and the length of the former's pace is to the latter's as 4 to 5. Where will they meet?

4. A draper bought a piece of silk measuring 52 yards for £14 17s. 6d. Four yards were damaged, and had to be sold for 2s. 3d. per yard. At what price per yard must he sell the remainder in order to clear 10 per cent. on the cost?

Grammar.

MALES AND FEMALES.

1. 'Knowledge and wisdom, *far* from *being one*,
Have ofttimes no connection. Knowledge dwells
In minds *replete* with thoughts of other men,
Wisdom in minds attentive to *their own*;
Knowledge, a rude unprofitable mass,
The mere *materials* with which wisdom builds,
Till *smoothed* and squared and fitted to its place,
Does but encumber what it seems *t'enrich*.
Knowledge is proud *that* he has learned *so much*,
Wisdom is humble that he knows no more.'

Paraphrase this passage.

2. Write out the subordinate sentences, and state the function and relation of each.

3. Parse the words printed in italics; and make a list of those derived from the Latin language.

4. What principle guides you in arranging words under the parts of speech? Write sentences to exemplify the use of each of the following words as three different parts of speech:—After, but, near, over.

Geography.

(*Answer two questions and draw one map.*)

1. Draw a map of one of the following:—
   (*a*) South America.
   (*b*) The Indian Ocean.
   (*c*) East Coast of Asia, with its chief islands.

2. Write what you know of the following places:—Hong-kong, Yokohama, San Francisco, Brisbane, Quito, Khartoum, Auckland, Antananarivo, Kandy, Natal, Corunna, Aleppo, Sofia.

3. Give an account of the distribution of volcanoes, and the regions of volcanic activity.

4. State briefly what you know of the moon, especially in its relation to the earth.

SECOND PAPER.

Two hours and a half allowed for this paper.

Needlework.

FEMALES.

(*One hour is allowed for the Exercises in Needlework.*)

Arithmetic.

MALES.

1. A certain sum placed out at simple interest for 3 years at 5½ per cent. per annum, brings in £18 8s. 9d. more in the 3 years than if it were placed out at compound interest for the same time at 5 per cent. per annum. What is the sum?

2. A man has a ship worth £9,500. He insures it at 3¾ per cent., so as to cover the value of the vessel and the cost of insurance. What premium has he to pay?

3. Explain clearly the method you adopt in division by a decimal fraction, and show how you would divide by a recurring decimal.

4. One watch gains 4 minutes in 24 hours, another loses 2 minutes in 36 hours. They are both set right at noon. What is the real time when the difference between them is 15 minutes?

History.

1. What eminent Englishmen engaged in the Crusades? Mention some of the effects which the Crusades had upon this country.

2. State some of the facts which indicate the great material progress made by England during the present Queen's reign.

3. What were the causes, the chief incidents, and the chief results of the continental war in the reign of Anne?

4. Name a dozen of the most important works in English literature, adding when and by whom they were written. Write more fully on any two of the works or authors.

Teaching.

Write notes of a lesson on the Barometer, or on the Ure of Mountains.

Music.

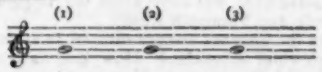
OLD NOTATION.

(N.B.—Pupil Teachers may answer the questions in either the Staff Notation or the Tonic Sol-fa, but *not both*.)

A quarter of an hour allowed for this paper.

1. Write in the Treble clef the ascending scale of E minor, using the minor sixth and the major seventh, and the ordinary descending scale of E minor.

2. Place above (1) an augmented second; (2) a major seventh; (3) a minor fourth:—



3. Add proper time-signatures to the following:—

TONIC SOL-FA.

1. Write (1) above *soh* an augmented second; (2) above *soh* a major seventh; and (3) above *soh* a minor fourth.

2. In what ways does the minor mode differ from the major mode?

3. Write the following phrase in two-pulse measure, so as to preserve the relative length of the notes:—

| d : - : - | r : - : - | m : r : d | r : m : r |

| d : - : - | - : - : - |

—0—

Certificate Examination, 1885.

MALE CANDIDATES.

SECOND YEAR.

British History.

Two hours and a half allowed for this paper.

Candidates are not permitted to answer more than *eight* questions, and are advised to answer the last.

1. What were the Six Acts passed by the Liverpool Ministry in 1819?

2. Name the chief members of Canning's Ministry (1827) and the members of Lord Liverpool's Ministry who refused to join it.

3. What legislative measures affecting Ireland were passed in the reign of George IV.?

4. Give some account of the chief provisions of the first Reform Bill.

5. What were the six points of the Charter adopted by the Chartists? Which of these have since been carried in Parliament, and when?

6. When was an Education Grant first made from public money? By whom was the grant administered? What is the constitution of the Committee of Privy Council on Education?

7. What were the principal foreign events affecting England in the year 1842?

8. What were the chief fiscal changes effected by Sir R. Peel in the year 1844-45?

9. Give a short account of the Repeal of the Corn Laws.

10. Describe the constitution of the Australian Colonies. What are the chief points of connection with the Mother Country?

11. What circumstances gave rise to the Crimean War? State the terms of peace affecting the navigation of the Black Sea.

12. What were the grounds of the *Alabama* claims which were brought by the American Government against England? How were they settled?

13. What were the chief provisions of the Education Act of 1870? How is the liberty of conscience protected by that Act?

14. Prepare the outline of a lesson for an advanced class upon the growth of our colonial Empire between the years 1815-70.

Geography.

Two hours and a half allowed for this paper.

Candidates must not answer more than *eight* questions, and are advised to answer the first and last.

1. Draw a map of—(*a*) Cape Colony; *or* (*b*) New Zealand; *or* (*c*) Ireland.

N.B.—Each map should be drawn on a scale sufficient to occupy all the blank space available. If the candidate put in,

and correctly number the lines of latitude and longitude, it will add to the value of the exercise.

Places must not be indicated by letters and figures, referring to a list of names at the side, but *the names themselves must be inserted in the map*.

2. Describe fully the county of Lancashire, *or* Norfolk, *or* Aberdeen.

3. With what ranges of hills or mountains are Ben Nevis, Helvellyn, and Snowdon connected? Describe the district in which one of them lies.

4. Describe the chief fishing towns of the east coast of Great Britain, and state what you know about the Dogger Bank, the Goodwin Sands, and Yarmouth Roads.

5. How are the Channel Islands situated as regards France? What are their chief industries? How long have they formed part of the English Dominions? How are they governed?

6. Into how many provinces is British India divided for purposes of government? Describe one of these provinces.

7. The first settlements of the English in India were at Surat, Fort St. George, and Bombay; the first provinces conquered were Bengal, Behar, and Orissa; say briefly what you know about each of those towns and divisions.

8. Describe the physical features of Ceylon, and enumerate the principal articles of export.

9. Give a brief history of the acquisition of Canada proper. What were the causes of the recent disturbances in the Dominion of Canada?

10. Say what you know about the reptile life, the marsupials, and the forest trees of Australia.

11. Describe the mountain system of New Zealand. What volcanic phenomena are presented by these islands?

12. Explain the names Windward and Leeward Islands; and describe particularly the Bermudas.

13. Describe the climate of the West African Settlements. Name their chief articles of trade, and describe their means of communication with the interior of Africa.

14. Prepare the outline of a lesson for an advanced class upon—

(*a*) The mixture of races in Cape Colony;

or (*b*) A voyage from Liverpool to Mauritius, stopping at St. Helena and Cape Town;

or (*c*) The chief coaling stations for our fleet, distributed throughout the great Oceans.

Euclid.

Three hours allowed for this paper.

[Not more than *eight* questions to be answered.]

N.B.—Capital letters, not numbers, must be used in the diagrams.

The only signs allowed are + and =. The square on AB may be written 'sq. on AB,' and the rectangle contained by AB and CD, 'rect. AB, CD.' Other abbreviations, if employed, must not be ambiguous.

1. Triangles on the same base and between the same parallels are equal.

Two triangles are on the same base and the same side of it, and one triangle is double of the other; show that a line drawn through the vertex of the smaller triangle, parallel to the base, bisects the sides of the larger triangle.

2. To describe a square on a given straight line.

Describe a rhombus on the same straight line equal to one-half of the square described.

3. If a straight line be divided into two equal parts, and also into two unequal parts, the rectangle contained by the unequal parts, together with the square on the line between the points of section, is equal to the square on half the line.

Divide a given straight line into two parts so that the rectangle contained by them may be equal to three-fourths of the square on half the line.

4. To describe a square that shall be equal to a given parallelogram.

Divide a given straight line into two parts such that the rectangle contained by them may be equal to the square described on a given straight line which is less than half the straight line to be divided.

5. If a straight line drawn through the centre of a circle bisect a straight line in it which does not pass through the centre, it shall cut it at right angles.

Show that the bisected line is the shortest chord that can be drawn through the point of bisection.

6. To draw a straight line from a given point without the circumference to touch a given circle.

If two circles touch each other externally the common tangent at the point of contact bisects the two other common tangents.

7. In equal circles equal arcs are subtended by equal straight lines.

Show that an equilateral triangle is greater than a right-angled isosceles triangle, both being described in the same circle.

8. If a straight line touch a circle, and from the point of contact a straight line be drawn cutting the circle, the angles which this line makes with the line touching the circle shall be equal to the angles which are in the alternate segments of the circle.

If two circles touch each other externally, right-angled triangles are formed by joining this point of contact with the points of contact of their common tangents.

9. To inscribe a circle in a given triangle.

If the given triangle be equilateral, the triangle formed by joining the points of contact will be one-fourth of the given triangle.

10. To describe a hexagon in a given circle.

If a circle touch three adjacent sides of a regular hexagon internally it will touch the other three sides.

11. In a right-angled triangle, if a perpendicular be drawn from the right angle to the base, the triangles on each side of it are similar to each other.

Hence show that if a straight line passing through the centre of a circle bisect another chord, the square on half the chord is equal to the rectangle contained by the two parts of the line.

12. Equal triangles which have one angle of the one equal to one angle of the other, have their sides about the equal angles reciprocally proportional.

Show that if the triangles (not being coincident) stand upon the same base and upon the same side of it they are between the same parallels.

13. Describe a circle of given radius which shall touch two given lines.

14. If three chords be drawn parallel to one another through the angular points of an equilateral triangle inscribed in a circle the circumference will be divided into three equal arcs.

Algebra and Mensuration.

Three hours allowed for this paper.

Candidates are not permitted to answer more than *eleven* of these questions.

The *solution* must be given at such length as to be intelligible to the examiner, otherwise the answer will be considered of no value.

ALGEBRA.

1. Sum the following series to 12 terms:—

$$\frac{a+2b}{a-b}+\frac{3a-b}{a-b}+\frac{5a-4b}{a-b}$$

and find the arithmetical series of which 11 and 120 are the 3rd and 9th terms.

2. If $a : b :: c : d$, show that

$$\frac{a^{12}-3b^{12}}{(a+b)^{12}}=\frac{c^{12}-3d^{12}}{(c+d)^{12}}$$

If $\frac{x^2}{a^2}$ vary as $1-\frac{y^2}{b^2}$ and when $x=a$, $y=o$, find the equation between x and y.

3. Assuming that the number of permutations of (n) things taken (v) together $=n(n-1)(n-2)\ldots(n-v+1)$, show that the number of permutations taken ($v+1$) together $=n(n-1)(n-2)\ldots(n-v)$.

How many words of 3 letters can be formed from 12 consonants and 3 vowels, each word having a vowel for the middle letter, and consonants for the others?

4. Expand $(4x+5y)^7$; and write down the middle term of $(a-b)^{10}$ and the 5th term of $(1-x)^{-\frac{1}{2}}$.

5. Prove that the total number of combinations of (n) things taken 1, 2, 3 ——— n at a time $=2^n-1$.

6 Prove that $\log.\frac{a^m}{b^n}=m\log.a-n\log.b$.

Given log. $7=\cdot8450980$ and log. $252=2\cdot4014005$, find the log. of 49, $\cdot36$ and $(252)^5$.

Of how many digits will the last-named quantity be composed?

7. Find a formula for the amount of a given sum in a given time at a given rate per cent. per annum compound interest.

In what time will a sum of money treble itself at 6 per cent. per annum compound interest?

Log. $3=\cdot4771213$

Log. $106=2\cdot0253059$.

8. Transfer 7497 from the denary to the septenary scale.

Express in the denary scale the difference between the greatest and least number that can be formed with four digits in the senary scale.

9. Solve the equations :—

$$(1)\quad \sqrt{x+10}+\sqrt{x-10}=\frac{60}{\sqrt{x+10}}$$

$$(2)\quad \left.\begin{matrix} x^2-xy=20 \\ x^2+y^2=26 \end{matrix}\right\}$$

10. Find a number such that if it is divided into 8 equal parts, their continued product is equal to the continued product if the number is divided into 4 equal parts.

11. If A were to do a piece of work by himself he would take four times as long as B and C together ; if B were to do the same work by himself, he would take three times as long as A and C together ; show that if C were to do the same work by himself, he would take nine-elevenths of the time in which A and C together would do it.

MENSURATION.

1. A pyramid stands on a square base, which contains 14,400 square feet, and the length of an edge is 100 feet ; find the volume of the pyramid in cubic feet to two places of decimals.

2. A cubical block of wood is put into a lathe and turned into a sphere, with the least possible waste of material ; compare the weights of the wood before and after it was turned.

3. How many gallons of water can be contained in a cylinder, whose internal radius is 9 feet, and its height 20 feet, if a gallon contains 277·274 cubic inches ?

4. A stone trough of the form of a parallelopiped, 12 feet long, 8 feet broad, and $4\sqrt{3}$ feet in depth, is tilted up so that its longer edge makes an angle of 30° with the ground, what volume of water can be poured in without overflowing ?

Grammar and Composition.

Three hours allowed for this paper.

No candidates may omit the exercise in composition.

COMPOSITION.

N.B.—This exercise must not extend beyond this page, but it may occupy all the blank space available.

Write in plain prose an essay on *one* of the following subjects :—

(*a*) The discovery of the Bermudas ;
or, (*b*) The belief in witchcraft in the days of Elizabeth ;
or, (*c*) 'Some kinds of baseness are nobly undergone ;'
or, (*d*) 'We are such stuff as dreams are made on.'

GRAMMAR.

1. Paraphrase the following passages :—

He being thus lorded
Not only with what my revenue yielded,
But what my power might else exact, like one
Who having unto truth, by telling of it,
Made such a sinner of his memory
To credit his own lie, he did believe
He was indeed the duke, out of the substitution
And executing the outward face of royalty
With all prerogative ; hence his ambition growing
To have no screen between this part he played
And him he played it for, he needs will be
Absolute Milan.

You were kneeled to and importuned otherwise
By all of us, and the fair soul herself
Weighed between loathness and obedience, at
Which end o' the beam should bow.

There be some sports are painful, and their labour
Delight in them sets off ; some kinds of baseness
Are nobly undergone, and most poor matters
Point to rich ends.

These our actors,
As I foretold you, were all spirits, and
Are melted into air, into thin air ;
And, like the baseless fabric of this vision,
The cloud-capped towers, the gorgeous palaces,
The solemn temples, the great globe itself,
Yea, all which it inherit shall dissolve,
And, like this unsubstantial pageant faded,
Leave not a rack behind.

Grammar and Composition.

2. Comment briefly on the following :—To trash for overtopping ; come from thy ward ; the liberal arts ; at least two glasses ; the red plague ; an eye of green : a living drollery ; ten leagues beyond man's life ; put to the foil ; pole-clipt vineyard.

3. Derive the following words :—Welkin, bootless, inveterate, sorceries, gaberdine, poison, chirurgeon, flatlong, ecstasy, inch-meal, hoodwink, invest, lieutenant.

4. Give the force of the prefixes in the following :—Bestir, perdition, endowed, prologue, abjure, subtleties, and explain the construction of 'me' in methinks.

5. Show that the meaning of the following words has been narrowed since the time of Shakespeare :—Impertinent, complexion, merely, premises, features, proper, conduct, constant, control, fearful, suggestion, observation, distemper.

6. What is peculiar in this play in the use of the word 'backward,' 'confederate'? Give some peculiarities of grammatical usage in this play.

7. The plays of Shakespeare have been divided into two periods ; contrast these periods, and show, by quotations, to which of the two periods you consider the 'Tempest' to belong.

8. Illustrate from the 'Tempest' some of the characteristic beauties of the style of Shakespeare.

Greek.

Male candidates may answer questions in *two* languages

Two hours allowed for this paper.

Section I.

Translate into English :—

(*a*) Εἰ δέ τις αὖ ὑμῶν ἀθυμεῖ ὅτι ἡμῖν μὲν οὐκ εἰσὶν ἵπποι, τοῖς δὲ πολεμίοις πολλοὶ πάρεισιν, ἐνθυμείσθω ὅτι οἱ μὲν ἵππεῖς οὐδὲν ἄλλο ἢ μύριοί εἰσιν ἄνθρωποι. ὑπὸ μὲν γὰρ ἵππου ἐν μάχῃ οὐδεὶς πώποτε οὔτε δεχθεὶς οὔτε λακτισθεὶς ἀπέθανεν· οἱ δὲ ἄνδρες εἰσὶν οἱ ποιοῦντες ὅ τι ἂν ἐν ταῖς μάχαις γίγνηται. Οὐκοῦν τῶν γε ἵππέων πολὺ ἡμεῖς ἐν ἀσφαλεστέρῳ ὀχήματί ἐσμεν· οἱ μὲν γὰρ ἐφ' ἵππων κρέμανται φοβούμενοι οὐχ ἡμᾶς μόνον ἀλλὰ καὶ τὸ καταπεσεῖν· ἡμεῖς δ' ἐπὶ τῆς γῆς βεβηκότες πολὺ μὲν ἰσχυρότερον παίσομεν ἤν τις προσίῃ, πολὺ δ' ἔτι μᾶλλον ὄτου ἂν βουλώμεθα τευξόμεθα. Ἔνι δὲ μόνῳ προέχουσιν οἱ ἵππεῖς ἡμᾶς· φεύγειν αὐτοῖς ἀσφαλέστερόν ἐστιν ἢ ἡμῖν.

Parse δηχθείς, καταπεσεῖν, βεβηκότες, ὅτου.

(*b*) ἐπεὶ μετέστην δεῦρ' Ἰωλκίας χθονὸς
πολλὰς ἐφέλκων ξυμφορὰς ἀμηχάνους,
τί τοῦδ' ἂν εὕρημ' εὗρον εὐτυχέστερον
ἢ παῖδα γῆμαι βασιλέως φυγὰς γεγώς ;
οὐχ, ᾗ σὺ κνίζει, σὸν μὲν ἐχθαίρων λέχος,
καινῆς δὲ νύμφης ἱμέρῳ πεπληγμένος,
οὐδ' εἰς ἅμιλλαν πολύτεκνον σπουδὴν ἔχων·
ἅλις γὰρ οἱ γεγῶτες οὐδὲ μέμφομαι·
ἀλλ' ὡς, τὸ μὲν μέγιστον, οἰκοῖμεν καλῶς,
καὶ μὴ σπανιζοίμεσθα, γιγνώσκων ὅτι
πένητα φεύγει πᾶς τις ἐκποδὼν φίλος,
πόῖδας δὲ θρέψαιμ' ἀξίως δόμων ἐμῶν,
σπείρας τ' ἀδελφοὺς τοῖσιν ἐκ σέθεν τέκνοις
ἐς ταὐτὸ θείην, καὶ ξυναρτήσας γένος
εὐδαιμονοίην. σοί τε γὰρ παίδων τί δεῖ ;
ἐμοί τε λύει τοῖσι μελλουσιν τέκνοις
τὰ ζῶντ' ἀνῆσαι. μῶν βεβούλευμαι κακῶς.
οἰδ' ἂν σὺ φαίης, εἰ σε μὴ κνίζοι λέχος.

Parse μετέστην, γῆμαϊ, τὰ ζῶντα, φαίης.

Section II.

Translate into Greek :—

(*a*) When he returned, he tells the prophecy to Socrates.

(*b*) Without commanders, nothing either of distinction or of success can be done in anything, but especially in matters connected with war.

(*c*) Our forefathers overcame their forefathers both by sea and land.

(*d*) Xerxes, having collected a very large army, advanced against Greece.

(*e*) The river, which is broad and deep, flows through the city.

(*f*) He said that the road which I saw on my right led to a large and wealthy city.

Section III.

1. Write a short outline of the plot of the 'Medea,' and complete the τεταλογία of the 'Medea.'

2. Give some of the uses of the particle ἄν according to the mood of the verb with which it is connected.

3. What classes of verbs admit of a double accusative ? Illustrate your answer by suitable examples.

4. Define accurately the meaning and use of the Aorist. How is the first Aorist Active formed ? State any exceptions.

Political Economy.

Three hours allowed for this paper.

Candidates are not permitted to answer more than *eight* questions, and are advised to answer the *last*.

1. Show that gold and silver are marketable articles, whether as coin or as manufactured goods. Why are they suitable for small transactions ? How is their place supplied in larger transactions ?

2. Explain the term 'Capital.' How do large accumulations of capital affect the wages of the labouring classes ?

3. Explain how the rate of wages is affected by poor relief from public funds. What are the evils attending out-door relief?

4. Show that division of labour is attended by certain disadvantages, and illustrate your statements by the results of improvements in machinery employed in agriculture.

5. Explain how debasing the currency of the country affects its industries. Give illustrations from English history, and from the history of the French Revolution.

6. What considerations should be chiefly borne in mind in the investment of small savings? Give examples from history of the folly of an ignorant public attempting to combine a high rate of interest with safety of capital.

7. Under what conditions of the market are strikes generally resorted to? What councils have been proposed for averting strikes?

8. How is the rent of land determined? Give some of the causes which have depressed English agriculture during the last ten years.

9. Show the truth of the statement that wages are increased by increasing the produce of labour. How is this compatible with the present over-production in the iron trade?

10 Discuss the advantages of small portions of land held in freehold by peasant proprietors.

11. How does a bank make its profit? What is meant by a run upon a bank? In what cases may a run upon a bank cause its failure?

12. Distinguish direct and indirect taxation. What taxes are levied indirectly at the present time in England on necessaries and on luxuries?

13. Point out some of the civilising effects of trade with barbarous nations. Illustrate by the story of Livingstone's life.

14. Prepare the outlines of a lesson to an advanced class on—(*a*) The history of the poor-laws, especially in their bearing upon the rate of wages; or (*b*) The evils of monopolies; or (*c*) The various modes of tenancy of agricultural land.

SECOND YEAR.

FEMALE CANDIDATES.

British History.

Three hours allowed for this paper.

Candidates are permitted to answer *eight* questions only, and must confine themselves to those in one section.

Section I. (1154-1399).

1. Write a short life of Simon de Montford.

2. By what different means did Richard I. raise money for his Crusade? What were the ordinary sources of the King's revenue at the time?

3. Sketch shortly the condition of Ireland in the time of Henry II. On what did he base his claim to sovereignty over Ireland, and what induced him to enforce the claim?

4. Edward I., in his wars and in his domestic policy, showed far greater wisdom than his predecessors. Show that this is true.

5. Describe the relations between England and Scotland in the reign of Edward III.

6. Trace the gradual changes taking place in the mode of warfare during the period 1154-1399. Had these changes any effect other than on warfare?

7. Give some account of the rise of the Lollards. In what ways did they seek to reform the Church?

8. Weak sovereigns always give themselves up to favourites. Show that this is true from the history of the period you have been studying.

9. Sketch the life and character of Edward the Black Prince.

10 What do you know of the Statutes of Præmunire, Mortmain, Labourers?

Section II. (1714-1837).

1. What was the general object of the Whig ministries of George I. and George II. in (*a*) their domestic, (*b*) their foreign policy?

2. Sketch the career of Warren Hastings.

3. What led England to take part in the War of the Austrian Succession? Give some account of the share she took in it.

4. How did George III. succeed in increasing the personal influence of the Crown? Name some of the results of his influence.

5. Give some account of the Battle of Copenhagen, and say what led to the war with Denmark.

6. What were the causes which contributed to the success of the movement started by Wesley and Whitfield.

7. Describe the state of affairs in Ireland which rendered the Union desirable. How was it brought about?

8. What led to the war with America in 1812? Give some account of that war.

9. What do you know about the Berlin Decrees, the Mutiny at the Nore, the Luddites?

10. Give an account of the passing of the Catholic Emancipation Bill.

11. Trace shortly the growing influence of the Press as a power in politics in the reign of George III.

Geography.

Three hours allowed for this paper.

No candidate is permitted to answer more than *eight* questions, and the first question should not be omitted by any.

1. Draw a map (occupying the enclosed space) of Scotland south of the Caledonian Canal, or of New South Wales and Victoria, giving the principal physical features, the more important towns, and the lines of latitude and longitude.

2. Mention the animals used as beasts of burden in the various parts of the British Empire, and show in each case their special adaptability.

3. Give sufficiently full details to prove the truth of the saying, 'The sun never sets on the British Empire.'

4. State which one of the British possessions is most noted for the production of each of the following articles:—Tea, coffee, pepper, oil, salmon, wool, mutton, flax, rice, cotton, wine, timber.

5. Describe in words the course of the rivers Clyde and Indus, and draw small illustrative sketch-maps.

6. Describe fully a coasting voyage from Bombay to Calcutta, or from Londonderry to Waterford Harbour.

7. Point out the peculiar advantage of our occupation of each of the following places:—Hong Kong, Malta, Gold Coast, Aden, Cyprus. Illustrate by small sketch-maps.

8. Arrange in order, according to their distance from London, the following places:—Belfast, Glasgow, Aberdeen, Ceylon, Ballarat, Birmingham, Calcutta, Bombay, Quebec, Cape Town—giving, where you can, the approximate distance of each from London.

9. Describe the exact position of *eight* of the following places, and mention anything worthy of note connected with each:—Hobart Town, Dunedin, Lucknow, St. John's, Manitoba, Port Elizabeth, Sierra Leone, Durban, Lough Foyle, Bannockburn, Belfast, Brisbane.

10. Write what you know of the chief physical features, the climate, the population, and the industries of Ireland.

11. Give notes of a first lesson to a Sixth Standard on the British possessions in the West Indies and South America.

12. Describe briefly the chief points of interest to a visitor in Edinburgh, Calcutta, and Melbourne, and mention the most important industries of the inhabitants.

13. Give a list of the British possessions in the north temperate, tropical, and south temperate zones respectively.

14. Describe a journey by land from Aberdeen to London, or across the south of Canada from the Atlantic to the Pacific Ocean.

Arithmetic.

Two hours and a half allowed for this paper.

No candidate is permitted to answer more than *ten* questions.

The *solution* must be given at such length as to be intelligible to the examiner, otherwise the answer will be considered of no value.

1. State the rule for simple long division, and explain the process by which the quotient is obtained; taking for your example $1169134 \div 3379$. How may the work be abridged if the divisor terminates with cyphers?

2. What is meant in arithmetical language by 'factor,' 'power,' 'numeration,' 'prime and composite numbers,' 'greatest common measure,' 'root,' 'ratio'? Give examples.

3. (A) $\frac{3}{7} \times 8 = 2\frac{4}{7}$. (B.) $\frac{3}{7} \div 4 = \frac{3}{28}$.

State the rule in each of these two cases, and give the reason for the process.

4. Give and explain the rule for reducing vulgar fractions to decimals. What decimal of £35 0s. $3\frac{3}{4}$d. did I receive on being paid $3\frac{1}{2}$ of £3 12s. $6\frac{3}{4}$d.?

5. No. 1585 of a weekly publication came out on the 13th March, 1879; at what date did No. 1 appear?

6. Define 'average,' and give the rule for ascertaining it. What is the average age of all the members of a club consisting of 27 persons, if 9 of them average $28\frac{1}{2}$ years of age, 3 of them $38\frac{3}{4}$ years, 8 of them 61 years, and the remainder 75 years?

7. Divide 5 guineas among 3 persons, A, B, and C, so that they may have shares proportionate to $\frac{1}{2}$, $\frac{2}{3}$, and $\frac{1}{4}$.

8. Explain the term 'per cent.'

What percentage of 1 ton is each of the following quantities: (*a*) $1\frac{1}{2}$ cwt., (*b*) 1 qr. 15lbs. 12 oz., (*c*) 2 lbs. $12\frac{1}{2}$ oz.?

9. At what time between 9 and 10 o'clock will the minute hand and hour hand of a clock be in one line opposite to each other? Explain the process by which you arrive at your result.

10. 'Discount equals given sum less present worth; present worth equals given sum less discount.' Explain, and give an illustration of this statement, and find the discount on £127 2s. for half a year at 5 per cent.

11. Define compound interest.

Find the difference between the compound interest on £840 for 3 years, at 5 per cent., and for 4 years at 4 per cent. (payable half-yearly in each case),—in decimals of £1.

12. A and B are twins, aged 26 years. A determines to invest £25 on his 27th and each succeeding birthday at 4 per cent. simple interest.—B at the same time insures his life for a certain sum, paying an annual premium of £2, being $1\frac{1}{2}$ per cent. on the sum assured. Compare the amount which A and B respectively will have to bequeath, dying at the commencement of their 33rd year, after A has made his sixth investment.

13. What is meant by saying 'the 3 per cents. are at a discount'? If those securities be standing at $87\frac{1}{2}$, and railway debentures paying $4\frac{1}{2}$ per cent. are at a premium of 25 per cent., by which investment can the larger income be secured; and by how much will it exceed the smaller, if the sum invested be £2613 15s.?

14. Explain what is meant by 'stock.' A broker is employed to invest a sum of money in the Funds, and receives as brokerage £45—being $\frac{1}{8}$ per cent. on the purchase-money, and $\frac{1}{16}$ per cent. on the nominal value of the stock. What was the amount of stock purchased, and at what price per cent. was it standing?

Grammar and Composition.

Three hours allowed for this paper.

No candidate may omit the exercise in composition, or attempt more than *one* of the passages (A. and B.) from Shakespeare.

COMPOSITION.

N.B.—This exercise must not extend beyond this page, but it may occupy all the blank space available.

Write in plain language an essay on *one* of the following:—

1. Recreations.
2. Self-Respect.
3. The Post-office.
4. 'Sermons in stones—books in the running brooks.'

GRAMMAR.

Paraphrase, and where necessary, explain and illustrate the following passage:—

Prospero. (A.)

Ye elves of hills, brooks, standing lakes and groves,
And ye that on the sands with printless foot
Do chase the ebbing Neptune, and do fly him,
When he comes back; you demi-puppets, that
By moonshine do the green-sour ringlets make
Whereof the ewe not bites; and you whose pastime
Is to make midnight mushrooms; that rejoice
To hear the solemn curfew; by whose aid
(Weak masters though ye be) I have be-dimm'd
The noontide sun, called forth the mutinous winds
And 'twixt the green sea and the azured vault
Set roaring war: to the dread rattling thunder
Have I given fire, and rifted Jove's stout oak
With his own bolt: the strong-based promontory
Have I made shake; and by the spurs plucked up
The pine and cedar: graves at my command,
Have waked their sleepers, oped, and let them forth
By my so potent art: But this rough magic
I here abjure, and when I have required
Some heavenly music (which even now I do),
To work mine end upon their senses, that
This airy charm is for, I'll break my staff,
Bury it certain fathoms in the earth
And deeper than did ever plummet sound
I'll drown my book.

GRAMMAR AND COMPOSITION.

Paraphrase, and, where necessary, explain and illustrate the following passage:—

Prospero. (B.)

I, thus neglecting worldly ends, all dedicate
To closeness, and the bettering of my mind
With that which, but being so retired,
O'er-prized all popular rate, in my false brother
Awaked an evil nature: and my trust
Like a good parent, did beget of him
A falsehood, in its contrary as great
As my trust was, which had, indeed, no limit,
A confidence sans bound. He being thus lorded
Not only with what my revenue yielded,
But what my power might else exact,—like one,
Who having, unto truth, by telling of it,
Made such a sinner of his memory,
To credit its own lie,—he did believe
He was the duke; out of the substitution
And executing the outward face of royalty
With all prerogative.—Hence his ambition
Growing,—Dost hear?

Miranda.

Your tale, sir, would cure deafness.

Prospero.

To have no screen between this part he played
And him he played it for, he needs will be
Absolute Milan: me, poor man!—my library
Was dukedom large enough—of temporal royalties
He thinks me now incapable: confederates,
(So dry he was for sway) with the King of Naples
To give him annual tribute, do him homage,
Subject his coronet to his crown, and bend
The dukedom, yet unbowed, (alas! poor Milan!)
To most ignoble stooping.

N.B.—Not more than four of these questions are to be attempted.

1. Give a brief sketch of the plot of 'The Tempest.' Is the play to be classed among tragedies or among comedies, and why? What contemporary events are supposed to have suggested any of the incidents introduced?

2. To which period in the author's literary career is this drama generally assigned? How has it been attempted to fix the date of its first appearance?

3. Name some of the figures of speech most commonly used in poetry, and give examples of each from 'The Tempest.'

4. Give a short description of the characters, Prospero, Miranda, Gonzalo, Caliban.

5. Which appear to be the finest portions of the play? How do they illustrate the genius of Shakespeare?

Domestic Economy.

Three hours allowed for this paper.

No candidate is permitted to answer more than *eight* questions.

1. Write what you know on the subject of providing penny dinners for school children.

2. With what plans are you acquainted for a schoolmistress to invest her savings? Which do you recommend, and why?

3. A teacher on leaving college takes a school at (*a*) A stated salary plus house and garden, or (*b*) A fixed stipend plus share of grant and pence, but no house. Show the necessity of keeping an account of income and expenditure in both cases. What books should be kept?

4. In taking up domestic economy as an extra subject, how would you draw up a course of lessons to impart the subject-matter of the third stage?

5. What precautions have been taken in this country to prevent the introduction of cholera? Explain them, as to a fourth standard.

6. Write what you consider would be good advice to a class of sixth and seventh standard girls—*i.e.*, those about to leave school—on personal cleanliness.

7. It is generally understood that the labouring classes in France have a more economical mode of cooking than those of the same class in England. Can you explain this?

8. Compare the advantages and disadvantages of closed and open fireplaces in the kitchens of the labouring class.

9. Describe the method of conducting any cookery classes which you may have attended with reference to—

(*a*) Provision of apparatus, fuel, etc.
(*b*) Teacher's salary.
(*c*) Materials for demonstration lessons.
(*d*) Disposal of dishes produced.
(*e*) Benefit to the children attending.

10. Show the necessity for holidays in the case of a teacher, and say how the greatest benefit can be derived from them.

11. Describe a few nourishing dishes that may be easily prepared by a schoolmistress living alone.

12. An epidemic breaks out in a town; what plans should be adopted to prevent its spreading?

3. Explain how the rate of wages is affected by poor relief from public funds. What are the evils attending out-door relief?

4. Show that division of labour is attended by certain disadvantages, and illustrate your statements by the results of improvements in machinery employed in agriculture.

5. Explain how debasing the currency of the country affects its industries. Give illustrations from English history, and from the history of the French Revolution.

6. What considerations should be chiefly borne in mind in the investment of small savings? Give examples from history of the folly of an ignorant public attempting to combine a high rate of interest with safety of capital.

7. Under what conditions of the market are strikes generally resorted to? What councils have been proposed for averting strikes?

8. How is the rent of land determined? Give some of the causes which have depressed English agriculture during the last ten years.

9. Show the truth of the statement that wages are increased by increasing the produce of labour. How is this compatible with the present over-production in the iron trade?

10 Discuss the advantages of small portions of land held in freehold by peasant proprietors.

11. How does a bank make its profit? What is meant by a run upon a bank? In what cases may a run upon a bank cause its failure?

12. Distinguish direct and indirect taxation. What taxes are levied indirectly at the present time in England on necessaries and on luxuries?

13. Point out some of the civilising effects of trade with barbarous nations. Illustrate by the story of Livingstone's life.

14. Prepare the outlines of a lesson to an advanced class on—(*a*) The history of the poor-laws, especially in their bearing upon the rate of wages; or (*b*) The evils of monopolies; or (*c*) The various modes of tenancy of agricultural land.

SECOND YEAR.

FEMALE CANDIDATES.

British History.

Three hours allowed for this paper.

Candidates are permitted to answer *eight* questions only, and must confine themselves to those in one section.

Section I. (1154-1399).

1. Write a short life of Simon de Montford.

2. By what different means did Richard I. raise money for his Crusade? What were the ordinary sources of the King's revenue at the time?

3. Sketch shortly the condition of Ireland in the time of Henry II. On what did he base his claim to sovereignty over Ireland, and what induced him to enforce the claim?

4. Edward I., in his wars and in his domestic policy, showed far greater wisdom than his predecessors. Show that this is true.

5. Describe the relations between England and Scotland in the reign of Edward III.

6. Trace the gradual changes taking place in the mode of warfare during the period 1154-1399. Had these changes any effect other than on warfare?

7. Give some account of the rise of the Lollards. In what ways did they seek to reform the Church?

8. Weak sovereigns always give themselves up to favourites. Show that this is true from the history of the period you have been studying.

9. Sketch the life and character of Edward the Black Prince.

10 What do you know of the Statutes of Præmunire, Mortmain, Labourers?

Section II. (1714-1837).

1. What was the general object of the Whig ministries of George I. and George II. in (*a*) their domestic, (*b*) their foreign policy?

2. Sketch the career of Warren Hastings.

3. What led England to take part in the War of the Austrian Succession? Give some account of the share she took in it.

4. How did George III. succeed in increasing the personal influence of the Crown? Name some of the results of his influence.

5. Give some account of the Battle of Copenhagen, and say what led to the war with Denmark.

6. What were the causes which contributed to the success of the movement started by Wesley and Whitfield.

7. Describe the state of affairs in Ireland which rendered the Union desirable. How was it brought about?

8. What led to the war with America in 1812? Give some account of that war.

9. What do you know about the Berlin Decrees, the Mutiny at the Nore, the Luddites?

10. Give an account of the passing of the Catholic Emancipation Bill.

11. Trace shortly the growing influence of the Press as a power in politics in the reign of George III.

Geography.

Three hours allowed for this paper.

No candidate is permitted to answer more than *eight* questions, and the first question should not be omitted by any.

1. Draw a map (occupying the enclosed space) of Scotland south of the Caledonian Canal, or of New South Wales and Victoria, giving the principal physical features, the more important towns, and the lines of latitude and longitude.

2. Mention the animals used as beasts of burden in the various parts of the British Empire, and show in each case their special adaptability.

3. Give sufficiently full details to prove the truth of the saying, 'The sun never sets on the British Empire.'

4. State which one of the British possessions is most noted for the production of each of the following articles:—Tea, coffee, pepper, oil, salmon, wool, mutton, flax, rice, cotton, wine, timber.

5. Describe in words the course of the rivers Clyde and Indus, and draw small illustrative sketch-maps.

6. Describe fully a coasting voyage from Bombay to Calcutta, or from Londonderry to Waterford Harbour.

7. Point out the peculiar advantage of our occupation of each of the following places:—Hong Kong, Malta, Gold Coast, Aden, Cyprus. Illustrate by small sketch-maps.

8. Arrange in order, according to their distance from London, the following places:—Belfast, Glasgow, Aberdeen, Ceylon, Ballarat, Birmingham, Calcutta, Bombay, Quebec, Cape Town—giving, where you can, the approximate distance of each from London.

9. Describe the exact position of *eight* of the following places, and mention anything worthy of note connected with each:—Hobart Town, Dunedin, Lucknow, St. John's, Manitoba, Port Elizabeth, Sierra Leone, Durban, Lough Foyle, Bannockburn, Belfast, Brisbane.

10. Write what you know of the chief physical features, the climate, the population, and the industries of Ireland.

11. Give notes of a first lesson to a Sixth Standard on the British possessions in the West Indies and South America.

12. Describe briefly the chief points of interest to a visitor in Edinburgh, Calcutta, and Melbourne, and mention the most important industries of the inhabitants.

13. Give a list of the British possessions in the north temperate, tropical, and south temperate zones respectively.

14. Describe a journey by land from Aberdeen to London, or across the south of Canada from the Atlantic to the Pacific Ocean.

Arithmetic.

Two hours and a half allowed for this paper.

No candidate is permitted to answer more than *ten* questions.

The *solution* must be given at such length as to be intelligible to the examiner, otherwise the answer will be considered of no value.

1. State the rule for simple long division, and explain the process by which the quotient is obtained; taking for your example $1169134 \div 3379$. How may the work be abridged if the divisor terminates with cyphers?

2. What is meant in arithmetical language by 'factor,' 'power,' 'numeration,' 'prime and composite numbers,' 'greatest common measure,' 'root,' 'ratio'? Give examples.

3. (A) $\frac{2}{3} \times 8 = 2\frac{2}{3}$. (B.) $\frac{3}{4} \div 4 = \frac{3}{16}$.

State the rule in each of these two cases, and give the reason for the process.

4. Give and explain the rule for reducing vulgar fractions to decimals. What decimal of £35 0s. $3\frac{3}{4}$d. did I receive on being paid $3\frac{1}{2}$ of £3 12s. $6\frac{3}{4}$d.?

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Grammar and Composition.

Three hours allowed for this paper.

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N.B.—This exercise must not extend beyond this page, but it may occupy all the blank space available.

Write in plain language an essay on *one* of the following:—

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And 'twixt the green sea and the azured vault
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With his own bolt: the strong-based promontory
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And him he played it for, he needs will be
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Was dukedom large enough—of temporal royalties
He thinks me now incapable: confederates,
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To give him annual tribute, do him homage,
Subject his coronet to his crown, and bend
The dukedom, yet unbowed, (alas! poor Milan!)
To most ignoble stooping.

N.B.—Not more than four of these questions are to be attempted.

1. Give a brief sketch of the plot of 'The Tempest.' Is the play to be classed among tragedies or among comedies, and why? What contemporary events are supposed to have suggested any of the incidents introduced?

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5. Which appear to be the finest portions of the play? How do they illustrate the genius of Shakespeare?

Domestic Economy.

Three hours allowed for this paper.

No candidate is permitted to answer more than *eight* questions.

1. Write what you know on the subject of providing penny dinners for school children.

2. With what plans are you acquainted for a schoolmistress to invest her savings? Which do you recommend, and why?

3. A teacher on leaving college takes a school at (*a*) A stated salary plus house and garden, or (*b*) A fixed stipend plus share of grant and pence, but no house. Show the necessity of keeping an account of income and expenditure in both cases. What books should be kept?

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Notes of Lessons on Ocean Currents.

BY JOS. H. COWHAM, F.G.S.,

Lecturer on School Method at the Westminster Training College.

MOVEMENTS OF WATER. PART III.

THE TIDES—LESSON II.

NOTES OF INFORMATION, ARRANGED UNDER HEADINGS.

A. Time of High Tide on Successive Days:—

1. **Observed Phenomena.**
   - (*a*) The tide is at its greatest height nearly an hour later each successive day.
   - (*b*) In this respect it resembles the moon, which rises nearly an hour later each successive evening.
2. **Question.**—Can this delay of High Tide each day be connected with the delay in the rising of the Moon?

B. Explanation of the Delay in the Appearance of High Tide on Successive Days:—

1. Whilst the earth is rotating on its axis from west to east, and thus causing two Tides per day on every meridian (see Lesson I.), the Moon is not stationary.

2. The Moon at the same time is revolving round the earth from west to east (see Fig. 1).

3. Each completed revolution of the Moon round the Earth occupies nearly 30 days. Therefore the Moon's orbital movement in one day amounts to $\frac{1}{30}$ of 360° or about 12° (see Fig. 2).

4. If now the movement of the earth on its axis and that of the moon in its orbit be taken together, it will be seen by reference to Diagram 2 that **the meridian *a*, after completing a rotation of earth movement, must pass on to *b* before the moon is again over it.**

   Hence the delay in the appearance of high tide on successive days is due to a selected meridian having to pass as many degrees over and above a completed diurnal rotation as the moon has passed in its orbit during the same time.

ILLUSTRATIONS AND OTHER TEACHING AIDS.

(*a*) Well known to all who live near the sea, and may be observed by others when visiting the seaside, or when staying near a tidal river.

(*b*) May be observed every month in the year. The New Moon is only visible early in the evening. As it changes its phases to Full Moon the moon rises later every evening.

2. This question may be stated; its answer is worked out below.

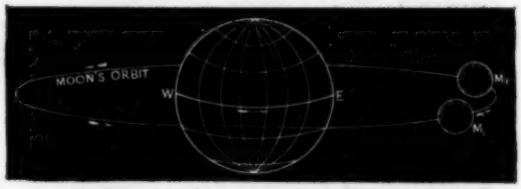


Fig. 1. Illustrating the Moon's movement round the Earth in the same direction as the Earth's movement on its axis.

M_1 to M_2 represents the Moon's movement during one diurnal rotation of the Earth.

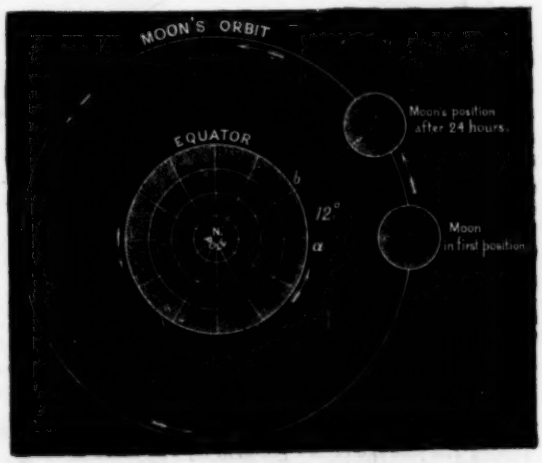


Fig. 2.—The Earth and Moon, viewed from above the Pole, showing the number of degrees (12) through which the meridian *a* must rotate before the Moon is over it.

In application of the general statement contained in 4, work the following exercises:—

(1) If the earth rotates at the rate of 360° in 24 hours, how long will it take the meridian *a* to travel to *b*, a distance of 12°?—Answer: 48 minutes.

(2) As 48 minutes represents the delay in the High Tide each successive day, 24 minutes will be the delay for each successive tide.

Neap and Spring Tides:—

1. Every fortnight the tide rises very high, and in a few hours it sinks very low. The *Range of Tide—i.e.*, the number of feet between high and low-water level is very great. **These tides are called Spring Tides.**

2. In the alternate weeks the tide neither rises so high, nor sinks so low as at Spring Tides. **These are Neap Tides.**

Reasons for Spring Tides:—

1. Every month, at *New* Moon, the Sun and Moon are in the same part of the heavens viewed from the Earth. They then act together in raising a very high tide.

2. Again, when the Moon is *full*, the Sun and Moon act together in heaping a higher tidal wave than usual on each side of the Earth.

   Note.—This Spring Tide is not usually so high as the Spring Tide at New Moon.

3. At New and Full Moon, therefore, the tidal waves at *a* and *b* (Fig. 3) are higher than at other times, whilst along the meridian *c*, *d* the water is lower than usual.

Reason for Neap Tides:—

1. When the moon is in *quadrature* the Sun and Moon neutralize, in part, each other's action.

   Note.—If the Sun were as powerful for the purposes of tide production as the Moon, they would more nearly neutralize each other's action; but the Sun is not so powerful. This is due to the fact that the distance of the Sun from the surface of the Earth does not very materially differ from its distance from the earth's centre (see Lesson I.).

   For proof of this latter statement apply the second *law* of gravitation, and work out the ratios in the method column below.

2. Because of the great tide-producing power of the Moon, a lunar tide is produced at *c*, *d*. This tide is not nearly so high as at New and Full Moon.

   The Sun does not now assist the Moon; on the contrary, it acts upon the water in the direction of *a*, *b*, thus preventing a very low tide at those places.

3. When the Moon, therefore, is in quadrature the tide neither rises so high nor sinks so low as at Spring Tides. These tides are called Neap Tides.

1 and 2. These phenomena are familiar to all who have access to the sea-shore or a tidal river.

A few questions upon sea-side experiences will elicit them from the class.

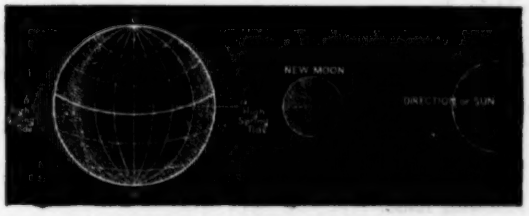


Fig. 3. Position of Sun and Moon at *New* Moon.

NOTE.—*The figures are not drawn to scale, only* position *is indicated. The shaded halves of the Moon in Figs.* 3 *and* 4 *are blackboard representations of the shaded side of the Moon's surface.*

2. In order to illustrate the position of Sun and Moon at Full Moon, remove the Moon to the opposite side of the Earth, against *b*.

3. The diagram sufficiently illustrates this statement.

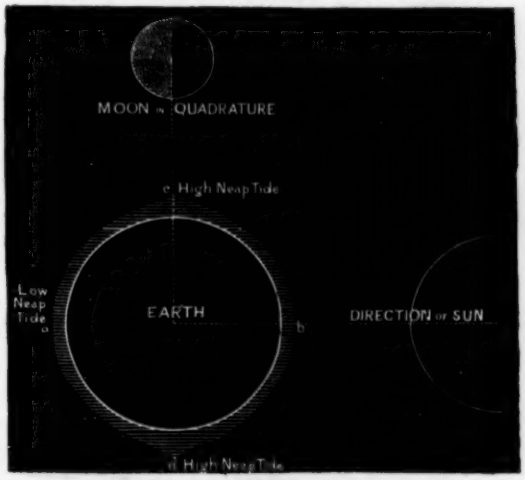


Fig. 4. Illustration of the causes of Neap Tides.

2. If the class is sufficiently advanced to understand ratios, the following statement will explain the difference between the Moon's tide-producing power and that of the Sun:—

$\left(\frac{1}{240,000}\right)^2 : \left(\frac{1}{236,000}\right)^2$ expresses Moon's power.

$\left(\frac{1}{93,000,400}\right)^2 : \left(\frac{1}{93,000,000}\right)^2$ expresses Sun's power.

Query Column.

RULES.

1. Each correspondent is restricted to *one question*. We should be much obliged if correspondents, who send questions for solution, would give (if possible) the required answer, and the source from which the question is obtained.

2. No query can be answered unless accompanied by the real name and address of the sender, not necessarily for publication, but as a guarantee of good faith and for facility of reference.

3. ☞ When a pseudonym is adopted it should be written at the end of the query, and the real name nd address on a separate piece of paper.

4. Correspondents are requested to write their queries *legibly*, and on one side of the paper only.

5. Replies will not be sent through the post.

6. Queries must reach the office *not later than the 12th of the month*, or they cannot be attended to in the following issue.

*** All communications for this column should be addressed—'*The Query Editor*,' *The Practical Teacher*, *Pilgrim Street, Ludgate Hill, London, E.C.*

Arithmetic.

1. LEICESTERSHIRE.—Suppose a pack of cards be made into 7 heaps, so that the spots on the bottom card of each heap, added to the number of cards laid thereon, may make 12, and then there are 12 cards left; find the number of spots on all the bottom cards.

Number of spots on the bottom cards
$+40$(number of cards left) $= 12 \times 7$
$= 84$,
$\therefore$ Number of spots on the bottom cards $= 84 - 40$
$= \underline{44}$. Ans.

2. HANNIBAL.—There are four vessels of equal capacity. The first is filled with spirit to the extent of one-eighth, the second to one-sixth, the third to one-fourth, and the last to one-third. The first is then filled up with water, and from this mixture the second is filled up; again, from this second mixture the third is filled up, and in like manner the fourth from the third. What proportion of spirit to water is there in the fourth vessel?—(*Hunter's* 'Problems in Higher Arithmetic.')

Quantity of spirit in second vessel $= \frac{1}{6} + \frac{5}{6}$ of $\frac{1}{8}$
$= \frac{1}{6} + \frac{5}{48}$
$= \frac{8+5}{48}$
$= \frac{13}{48}$;
,, ,, third ,, $= \frac{1}{4} + \frac{3}{4}$ of $\frac{13}{48}$
$= \frac{1}{4} + \frac{13}{64}$
$= \frac{16+13}{64}$
$= \frac{29}{64}$;
,, ,, fourth ,, $= \frac{1}{3} + \frac{2}{3}$ of $\frac{29}{64}$
$= \frac{1}{3} + \frac{29}{96}$
$= \frac{32+29}{96}$
$= \frac{61}{96}$;

$\therefore$ In fourth vessel,—

Quantity of spirit : Quantity of water
$:: \frac{61}{96} : 1 - \frac{61}{96}$,
$:: \frac{61}{96} : \frac{35}{96}$,
$:: \underline{61 : 35}$. Ans.

3. W. E.—A mixture of 16 parts of gin, costing 10s. 1½d. a gallon with 5 parts of water (costing nothing) is sold at 10s. 8d. a gallon; while one of 4 parts of rum, costing 15s. a gallon with 1 part of water is sold at 16s. a gallon. What proportion must be mixed with brandy, costing 30s. a gallon, so that if the mixture be sold at 33s. 6d. a gallon, the whole profit gained may be 40 per cent., supposing the quantity of diluted gin to be sold to be *thrice*, and that of the diluted rum to be *twice* that of the diluted brandy? (*Civil Service Exam. for Men Clerks, Lower Division, October*, 1885.)

Cost price of a gallon of gin $= \frac{16}{16+5}$ of 10s. 1½d.
$= \left(\frac{\overset{2}{\cancel{16}}}{\underset{7}{\cancel{21}}} \text{ of } \frac{\overset{27}{\cancel{81}}}{\underset{8}{\cancel{8}}}\right)$s.
$= \frac{27}{7}$s.
$= 7$s. $8\frac{4}{7}$d.;
,, ,, rum $= \frac{4}{4+1}$ of 15s.
$= \left(\frac{\overset{3}{\cancel{4}}}{\underset{1}{\cancel{5}}} \text{ of } \frac{\overset{3}{\cancel{15}}}{1}\right)$s.
$= 12$s.;

Selling price of 3 gals. of gin, 2 gals. of rum, and 1 gal. of brandy
$= (10\text{s. } 8\text{d.} \times 3) + (16\text{s.} \times 2) + 33\text{s. } 6\text{d.}$
$= 32\text{s.} + 32\text{s.} + 33\text{s. } 6\text{d.}$
$= 97\text{s. } 6\text{d.}$;

$\therefore$ £7 6 : 97 6 :: £5 : Cost price of 3 gals. of gin, 2 gals. of rum, and 1 gal. of brandy.

7 | 487 6
69 7½

Cost price of 3 gals. of gin and 2 gals. of rum
$= (7\text{s. } 8\frac{4}{7}\text{d.} \times 3) + (12\text{s.} \times 2)$
$= 23\text{s. } 1\frac{5}{7}\text{d.} + 24\text{s.}$
$= 47\text{s. } 1\frac{5}{7}\text{d.}$;
$\therefore$ Cost price of a gallon of brandy
$= 69\text{s. } 1\frac{5}{7}\text{d.} - 47\text{s. } 1\frac{5}{7}\text{d.}$
$= 22\text{s. } 6\text{d.}$;
$\therefore$ Proportion of brandy $= \frac{22\frac{1}{2}\text{s.}}{30\text{s.}}$
$= \frac{45}{60}$
$= \frac{3}{4}$;

$\therefore$ There must be 3 parts of brandy to one part of water. Ans.

4. PUZZLED.—A man bought a horse and carriage for £100, and sold the horse at a gain of 50 per cent. on its prime cost, and the carriage at a loss of 25 per cent., thus gaining 5 per cent. on his whole outlay; what were the buying and the selling prices of the horse and carriage respectively?

Cost price of horse + cost price of carriage = £100;
(Cost price of horse $\times \frac{150}{100}$) − (cost price of carriage $\times \frac{75}{100}$) = £5,
$\frac{1}{2}$ cost price of horse − $\frac{1}{4}$ cost price of carriage = £5,
Cost price of horse − $\frac{1}{2}$ cost price of carriage = £10;
$\therefore$ 1½ times cost price of carriage = £100 − £10 = 90,
$\therefore$ Cost price of carriage = £90 ÷ 1½
= £90 × ⅔
= £60,
And ,, ,, horse = £100 − £60
= £40;
Selling price of horse = £40 × ⅔
= £60,
And ,, ,, carriage = £60 × ¾
= £45. Ans.

5. ONE IN NEED OF HELP.—If I save £10 yearly and invest it in the three per cents., and always put in the interest with the savings for four years, what sum shall I have at the end of that time?

£
End of 1st year = 10
·3
10
„ 2nd „ = 20·3
·609
10
„ 3rd „ = 30·909
·92727
10
„ 4th „ = 41·83627
20
s. 16·72540
12
d. 8·7048

∴ Amount = £41 16s. 9d. nearly. Ans.

6. PHŒNIX.—I bought £128 5s. worth of goods, and kept them on hand for six months, when money was worth 8 per cent. I then sold at a net gain of 6 per cent.; for how much were they sold?

£ £ £
104
6
6·24
104
£128 : £128·24 :: £128.24 : Selling price.
4 5·13 27·56
5·13
8268
2756
13780
£141·3828
20
s. 7·6560
12
d. 7·872

∴ Selling price = £141 7s. 8d. nearly. Ans.

7. SCIENCE.—Took money out of a bank, giving 2½ per cent., and bought five £20 shares bearing interest at 8½ per cent., the shares to be paid in six equal instalments. I at once paid up five instalments, and at the end of a year and a half, the property having increased 17½ per cent. in value, I sold my shares; what did I gain by the whole transaction?

Gain on £100 = (£8½ − £2½) × 1½ + £17½
= (£6 × 1½) + £17½
= £9 + £17½
= £26½;
∴ Gain = 4/5 of £26½
= £26 10s. − £4 8s. 4d.
= £22 1s. 8d. Ans.

8. A CONSTANT READER.—A tea-dealer buys tea at 2s. 3d. and at 3s. 6d.; in what proportion must he mix them to sell at 4s. a lb. and thereby realise 20 per cent.?

Cost price per lb. of mixture = 4s. × 100/120
= 10/3 s.
= 3s. 4d.;

∴ Quantity at 2s. 3d. : Quantity at 3s. 6d.
:: 3s. 6d. − 3s. 4d. : 3s. 4d. − 2s. 3d.,
:: 2d. : 1s. 1d.,
:: 2 : 13. Ans.

9. X. P. T.—A ship is valued at £14,720; what sum should be insured at 8 per cent. by a person who owns 1/16 of the ship, so that in case of loss the insurer may recover both the value of his share of the ship and the premium paid?

Value of share = £14,720 ÷ 16
= £920;

£ £ £
100
8
∴ 92 : 920 :: 100 : Amount of insurance.
10

= £1,000. Ans.

10. HAMLET.—What sum will be left out of the amount realised by £1,000 of stock standing at 91 1/10, if enough be set aside to clear £43 12s. in 1 2/3 years at 3½ per cent. per annum, simple interest?

£3½ × 1 2/3 = (7/2 × 5/3) £ = 35/6 £;

£ £ s. £
∴ 35/6 : 43 12 :: 100 : Principal.
100
4360 0
16 £
77)69760 0(905
693
460
385
75
20
1500(19s.
77
730
693
37
12
444(5d.
385
59

∴ Amount left = (£91 1/10 × 10) − £905 19s. 5 5/7 d.
= £911 − £905 19s. 5 5/7 d.
= £5 0s. 6 2/7 d. Ans.

11. MYSTIC.—How much land, worth 17s. 6d. an acre, must be added to a farm of 51ac. 2ro. 20po. worth £1 14s. 6d. an acre, that the average value of the whole may be £1 2s. 9d. an acre?

£ s. d. £ s. d.
1 2 9 1 14 6
17 6 1 2 9
5 3 : 11 9 :: ac. ro. po. : Quantity of land.
12 12 51 2 20
63 141 47
21 47

21)2426 1 20
115 2 6 3/4

= 115ac. 2ro. 6¾po.
or 115 3/4 ac Ans.

12. MAGISTER.—If £1 sterling = 10 florins = 100 cents = 1000 milrees, express £2 11s. 11d. in that coinage.

Sum = (£2 11s. 11d. / £1 × 1,000) milrees
= 623 × 1000 / 240 milrees
25
6
= 2595 5/6 milrees
= 25 florins 9 cents 5 5/6 milrees. Ans.

13. ANON.—A sum of £250 17s. 6d. is transmitted through Paris to New York. £1 = 24 francs 79 cents. French; and 6 francs 20 cents. French = 2 dollars 25 cents American; what is the value of the sum in American currency?

£250 17s. 6d. = £250·875
24·79
2257875
1756125
1003500
501750
0219 19125 francs.

francs francs dollars
∴ 6·2 : 6219·19125 :: 2·25 : Sum in American currency.

2·25
3109595625
1243838250
1243838250
6·2)13993·1803125(2256·964566
124
159
124
353
310
431
372
598
558
400
372
28
283
248
351
310
412
372
405
372
33

=2,256·964566...dollars. Ans.

14. CROMWELL.—What would be the difference of income produced by investing in the 3 per cents. at 85½, the sum of £1,060 previously lent on a mortgage at 4½ per cent? (*Ricks.*)

Income from mortgage = 4½ per cent. on £1060
= £47 14s.;

£ £ £
85½ : 1060 :: 3 : Income from stock.
2 2
171)2120(37£
57
410
399
11
20
220(3s.
171
49
12
588(10d.
57
18

∴ Difference = (£47 14s. − £37 3s. 10$\frac{5}{19}$d.) decrease.
= £10 10s. 1$\frac{14}{19}$d. decrease. Ans.

15. NEMO.—Simplify:—

$$\frac{\cdot75\times\cdot58\frac{1}{3}}{1\cdot3571428}\times\frac{2\cdot8}{\cdot35}\times2\cdot\dot{7}14285\dot{}.$$

$$\frac{\cdot75\times\cdot58\frac{1}{3}}{1\cdot3571428}\times\frac{2\cdot8}{\cdot35}\times2\cdot\dot{7}14285\dot{}$$

$$=\frac{\frac{3}{4}\times\frac{7}{12}}{1\cdot3\frac{5}{7}}\times\frac{\cdot4}{\cdot05}\times2\frac{1}{7}$$

$$=\frac{\frac{7}{16}}{\frac{19}{4}}\times\frac{4}{3}\times\frac{15}{7}$$

$$=\frac{\frac{7}{4}}{\frac{19}{4}\times\frac{15}{1}}\times\frac{15}{7}$$

=7. Ans.

Algebra.

1. ANONYMOUS.—In an arithmetical series of an odd number of terms, the sum of the odd terms (the first, third, etc.) is 44, and the sum of the even terms (the second, fourth, etc.) is 33. Find the middle term and the number of terms. (*Todhunter.*)

Let $2n+1$ denote the whole number of terms;
Then, 44 is the sum of $n+1$ terms of the series:—

$$a+(a+2d)+(a+4d)+\ldots$$

$$\therefore 44=\frac{n+1}{2}(2a+2dn);$$

Then, 33 is the sum of n terms of the series:—

$$(a+d)+(a+3d)+\ldots$$

$$\therefore 33=\frac{n}{2}\{2(a+d)+2d(n-1)\}$$

$$=\frac{n}{2}(2a+2dn);$$

Hence, by division,

$$\frac{44}{33}=\frac{n+1}{n}$$

$$\frac{4}{3}=1+\frac{1}{n}$$

$$\frac{1}{n}=\frac{4}{3}-1$$

$$=\frac{1}{3}$$

$$\therefore n=3.$$

∴ No. of terms $=2n+1$
$=6+1$
$=7$. Ans.

Middle term $=a+dn$;

$$44=\frac{n+1}{2}(2a+2dn)$$

$$=n+1(a+dn)$$

$$\therefore a+dn=\frac{44}{n+1}$$

$$=\frac{44}{3+1}$$

$$=11.$$

∴ Middle term = 11. Ans.

2. ASPIRANT.—Find the H. C. F. of
$6x^3+25x^2-24x+5$ and $6x^3-31x^2+4x+5$.

$6x^3+25x^2-24x+5)6x^3-31x^2+4x+5(1$
$6x^3+25x^2-24x+5$
$-28x \mid -56x^2+28x$
$2x-1$

$2x-1)6x^3+25x^2-24x+5(3x^2+14x-5$
$6x^3-3x^2$
$28x^2-24x$
$28x^2-14x$
$-10x+5$
$-10x+5$

∴ H. C. F. = 2x − 1. Ans.

Note.—Please refer to Rule 1 of Query Column.

3. SEBASTIAN.—What is the condition that x^2+ax+b and x^2+cx+d should have a common factor? (*Easton's* 'Factors.')

$x^2+cx+d)x^2+ax+b(1$
x^2+cx+d
$(a-c) \mid (a-c)x+(b-d)$
$x+\frac{b-d}{a-c}$

$$x+\frac{b-d}{a-c})\,x^2+cx+d\,(\,x+(c-\frac{b-d}{a-c})$$

$$x^2+\frac{b-d}{a-c}x$$

$$(c-\frac{b-d}{a-c})x+d$$

$$(c-\frac{b-d}{a-c})\,x+\frac{c(b-d)}{a-c}-\frac{(b-d)^2}{(a-c)^2}$$

∴ $\frac{c(b-d)}{a-c}-\frac{(b-d)^2}{(a-c)^2}$ must equal d,
$c(b-d)(a-c)-(b-d)^2$ must equal $d(a-c)^2$,
∴ $(b-d)^2-c(b-d)(a-c)+d(a-c)^2=0$.

4. ANXIOUS.—Solve:—

$$\sqrt{\frac{a+x}{a-x}}+\sqrt{\frac{a-x}{a+x}}=\sqrt{5}.$$ (*Scholarship*, 1875.)

$$\sqrt{\frac{a+x}{a-x}}+\sqrt{\frac{a-x}{a+x}}=\sqrt{5}$$

Squaring each side $\left\{\frac{a+x}{a-x}+\frac{a-x}{a+x}+2\right.$ $\sqrt{\frac{a+x}{a-x}\times\frac{a-x}{a+x}}=5$

$$\frac{a+x}{a-x}+\frac{a-x}{a+x}+2=5$$

$$\frac{a^2+2ax+x^2+a^2-2ax+x^2}{a^2-x^2}=3$$

$$\frac{2a^2+2x^2}{a^2-x^2}=3$$
$$2a^2+2x^2=3a^2-3x^2$$
$$2x^2+3x^2=3a^2-2a^2$$
$$5x^2=a^2$$
$$x^2=\frac{a^2}{5}$$
$$\therefore\quad x=\pm\frac{a}{\sqrt{5}}.$$

5. RELIQUES.—How many different sums can be made with the following coins:—A penny, a sixpence, a shilling, a half-crown, a crown, and a sovereign? (*Algebra, Cambridge Local, Senior*, 1885.)

No. of coins = 6;

$$\therefore\ \text{No. of different sums}=6+\frac{6\cdot5}{1\cdot2}+\frac{6\cdot5\cdot4}{1\cdot2\cdot3}+\frac{6\cdot5\cdot4\cdot3}{1\cdot2\cdot3\cdot4}+\frac{6\cdot5\cdot4\cdot3\cdot2}{1\cdot2\cdot3\cdot4\cdot5}+1$$
$$=6+15+20+15+6+1$$
$$=63.\quad \text{Ans.}$$

6. PICKARD.—Two men, A and B, begin at the same time to run opposite ways once round a circular course, starting from the same point. From the moment at which they first meet A takes 63 seconds to finish the round, B 84 seconds; but whereas A ran at a uniform rate the whole way, B mended his pace in the ratio of 4 : 3 from the moment at which they first met. Find the time each takes to run the whole course. (*Civil Service Exam., Nov.*, 1885.)

Let x = Length of course in yds.,
And let y = Distance in yds. travelled by A when they meet;
Then, $\frac{x-y}{63}$ = A's rate per sec. in yds.,
And $\frac{y}{84\times\frac{4}{3}}$ = B's former rate per sec. in yds.;

$$\therefore\ y\div\frac{x-y}{63}=(x-y)\div\frac{y}{84\times\frac{4}{3}}$$
$$\frac{63y}{x-y}=\frac{112\,(x-y)}{y}$$
$$\frac{9y}{x-y}=\frac{16\,(x-y)}{y}$$
$$9y^2=16\,(x-y)^2$$
$$3y=4\,(x-y)$$
$$=4x-4y$$
$$7y=4x$$
$$\therefore\ y=\frac{4x}{7}.$$

$\therefore$ When they meet A has travelled $\frac{4}{7}$ of course;
$\therefore$ A travels $\frac{3}{7}$ of course in 63 sec.,
" $\frac{4}{7}$ " $63\text{ sec.}\times\frac{4}{3}$
$=84$ sec.;
$\therefore$ A takes 84 sec. + 63 sec. = 147 sec.
B " 84 sec. + 84 sec. = 168 sec.

7. HORSHAM.—Simplify:—

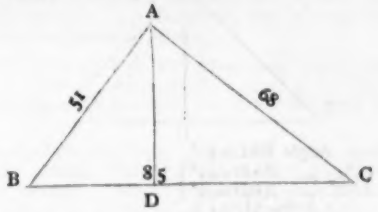
$$\frac{(a+b)^2-(m+n)^2}{(a+m)^2-(b+n)^2}\div\frac{(a-m)^2-(n-b)^2}{(a-b)^2-(n-m)^2}.$$

(*Senior.*)

$$\frac{(a+b)^2-(m+n)^2}{(a+m)^2-(b+n)^2}\div\frac{(a-m)^2-(n-b)^2}{(a-b)^2-(n-m)^2}$$
$$=\frac{\{(a+b)+(m+n)\}\{(a+b)-(m+n)\}}{\{(a+m)+(b+n)\}\{(a+m)-(b+n)\}}\div\frac{\{(a-m)+(n-b)\}\{(a-m)-(n-b)\}}{\{(a-b)+(n-m)\}\{(a-b)-(n-m)\}}$$
$$=\frac{(a+b+m+n)(a+b-m-n)}{(a+b+m+n)(a-b+m-n)}\div\frac{(a-b-m+n)(a+b-m-n)}{(a-b-m+n)(a-b+m-n)}$$
$$=\frac{a+b-m-n}{a-b+m-n}\div\frac{a+b-m-n}{a-b+m-n}$$
$$=1.\quad \text{Ans.}$$

Mensuration.

1. NORTHANTS.—The sides of a triangle are 51 feet, 68 feet, and 85 feet. Show that it is right-angled, and that the ratio of the areas of the triangle into which it is divided by a perpendicular from the right angle on the hypotenuse is 9 : 6. (*Moffatt's 'Pupil Teacher's Course.'*)



$$51^2+68^2=2601+4624$$
$$=7225$$
$$=85^2;$$
$\therefore$ The triangle is right-angled.

$$AD^2=AC^2-CD^2,$$
And $AD^2=AB^2-BD^2$; (I. 47.)
$$\therefore\ AC^2-CD^2=AB^2-BD^2,$$
$$68^2-(85-BD)^2=51^2-BD^2,$$
$$4624-(7225-170\,BD+BD^2)=2601-BD^2,$$
$$4624-7225+170\,BD-BD^2=2601-BD^2,$$
$$170\,BD-2601=2601,$$
$$170\,BD=2601+2601,$$
$$85\,BD=2601,$$
$$\therefore\ BD=\frac{2601}{85}$$
$$=\frac{153}{5}.$$

Area of $\triangle ABD=\frac{1}{2}(BD\times AD)$
$=(\frac{1}{2}\times\frac{153}{5}\times AD)$ sq. ft.
$=(\frac{153}{170}\,AD)$ sq. ft.;
" " $ACD=\frac{1}{2}(CD\times AD)$
$=\{\frac{1}{2}(85-\frac{153}{5})\times AD\}$ sq. ft.
$=(\frac{1}{2}\times\frac{272}{5}\times AD)$ sq. ft.
$=(\frac{272}{170}\,AD)$ sq. ft.
$\therefore$ Area of $\triangle ABD$: Area of $\triangle ACD$
:: 153 : 272,
:: 9 : 16.

2. GUILLAUME CANE.—Find the whole surface of a pyramid whose slant height, measured from the apex to the centre of one of the pentagonal sides of the base, is 10 feet, and each side of the base 20 inches. (*Lewis.*)

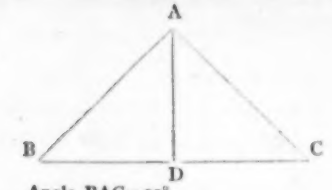
Surface of pyramid = area of base + area of sides

$$=\left\{5\times\left(\frac{20\text{ in.}}{2}\right)^2\times\cot\frac{180^\circ}{5}\right\}+\{\tfrac{1}{2}(20\text{ in.}\times5)\times10\text{ ft.}\}$$
$$=\{(5\times100)\text{ sq. in.}\times\cot36^\circ\}+(50\text{ in.}\times10\text{ ft.})$$
$$=(1\cdot376\,3819\times500)\text{ sq. in.}+(500\times12)\text{ sq. in.}$$
$$=(688\cdot19095+6000)\text{ sq. in.}$$
$$=6688\cdot19095\text{ sq. in.}$$
$$=144)6688\cdot19095(46\cdot44579$$

576
928
864
641
576
659
576
835
720
1150
1008
1420
1296
124

$=46\cdot44579\ldots$sq. ft. Ans.

3. FOLKESTONIAN.—A hemispherical bowl, whose internal radius is 1 foot, is filled with water, and placed on a horizontal table. In the water there is placed, with its vertex touching the centre of the bottom of the bowl and its axis vertical, a cone, whose vertical angle is 90°. Find the amount of water left in the bowl after the intrusion of the cone.



Angle BAC = 90°,
∴ " BAD = 45° }
And " ABD = 45° }
∴ DB = AD = 1 ft.
Content of bowl = ½ (2³ × ·5236) cub. ft.
= (·5236 × 4) cub. ft.
= 2·0944 cub. ft. ;
" " cone = ½ (2² × ·7854 × 1) cub. ft.
= (·2618 × 4) cub. ft.
= 1·0472 cub. ft. ;
∴ Quantity of water left in the bowl
= (2·0944 − 1·0472) cub. ft.
= 1·0472 cub. ft. Ans.

4. PUZZLED.—A cask weighing 1 cwt. 6 lbs. 2 oz. floats in a cubical cistern of water, whose side is 2 ft. 6 in. On the removal of the cask find how much the water will sink in the cistern, supposing a cubic foot of water weighs 63 lbs.

Surface of cistern = $\{(2\frac{1}{2})^2\}$ sq. ft.
= $\frac{25}{4}$ sq. ft. ;
Space occupied by cask = $\frac{1 \text{ cwt. } 6 \text{ lbs. } 2 \text{ oz.}}{63 \text{ lbs}}$ cub. ft.
= $\frac{118\frac{1}{8}}{63}$ cub. ft.
= $\frac{945}{504}$ cub. ft.
= $\frac{15}{8}$ cub. ft. ;
∴ Water will sink $\frac{15}{8}$ cub. ft. ÷ $\frac{25}{4}$ sq. ft.
= $\left(\frac{\cancel{15}^{3}}{\cancel{8}_{2}} \times \frac{\cancel{4}^{1}}{\cancel{25}_{5}}\right)$ ft.
= $\frac{3}{10}$ ft. Ans.

5. 4TH-YEAR P.T.—A room is 20 ft. long, 16 ft. wide, and 12 ft. high ; what is the distance from one of the lower corners to the opposite upper corner ?

Distance = $\sqrt{20^2 + 16^2 + 12^2}$ ft.
= $\sqrt{400 + 256 + 144}$ ft.
= $\sqrt{800}$ ft.

```
800 (28·284
  4
48 | 400
     384
562 | 1600
      1124
5648 | 47600
       45184
56564 | 241600
        226256
         15344
```

= 28·284...ft. Ans.

General.

1. W. R.—Having given sin 15° and cos 15°, find tan 15° and cot 15°.

$$\text{Tan } 15^\circ = \frac{\sin 15^\circ}{\cos 15^\circ}$$
$$= \frac{\sqrt{3}-1}{\sqrt{3}+1}$$
$$= \frac{(\sqrt{3}-1)(\sqrt{3}-1)}{(\sqrt{3}+1)(\sqrt{3}-1)}$$
$$= \frac{(\sqrt{3}-1)^2}{3-1}$$
$$= \frac{3-2\sqrt{3}+1}{2}$$
$$= \frac{4-2\sqrt{3}}{2}$$
$$= \underline{2-\sqrt{3}}.$$

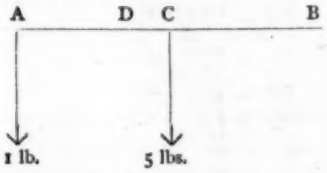
$$\text{Cot } 15^\circ = \frac{\cos 15^\circ}{\sin 15^\circ}$$
$$= \frac{\sqrt{3}+1}{\sqrt{3}-1}$$
$$= \frac{(\sqrt{3}+1)(\sqrt{3}+1)}{(\sqrt{3}-1)(\sqrt{3}+1)}$$
$$= \frac{(\sqrt{3}+1)^2}{3-1}$$
$$= \frac{3+2\sqrt{3}+1}{2}$$
$$= \frac{4+2\sqrt{3}}{2}$$
$$= \underline{2+\sqrt{3}}.$$

Or, $\cot 15^\circ = \frac{1}{\tan 15^\circ}$
$$= \frac{1}{2-\sqrt{3}}$$
$$= \frac{2+\sqrt{3}}{(2-\sqrt{3})(2+\sqrt{3})}$$
$$= \frac{2+\sqrt{3}}{4-3}$$
$$= \underline{2+\sqrt{3}}.$$

2. ANXIOUS.—The solution of your query appeared in our issue for September, 1883.

3. BURTONIAN.—Your query was solved in our issue for May, 1882.

4. FABIOLA.—A uniform rod, 2 ft. long and weighing 5 lbs., has a weight of 1 lb. placed at one extremity. Find the centre of gravity of the whole. (*Blaikie.*)



Let D be the centre of gravity of the whole ;
Then, taking moments :—
1 lb. × AD = 5 lbs. × DC,
AD = 5 DC
= 5 (AC − AD)
= 5 AC − 5 AD
AD + 5 AD = 5 AC
6 AD = 5 ft.
AD = $\frac{5 \text{ ft.}}{6}$ = 10 in.

∴ Centre of gravity is 10 in. from weighted end.

5. DERWENT.—The perimeter of a regular figure of twenty sides is 20 ft., and one of the long sides of one of the isosceles triangles, into which it can be divided, is ½ ft., or 20 in. Find the area of the figure.—The answer given in the book is wrong. Your result, 8·239...sq. ft. (as worked), is perfectly correct ; but the problem, as given, is not quite possible—that is to say, a regular pentagon, whose perimeter is 20 ft., could not be quite inscribed in a circle whose radius is exactly 20 in.

The ratio between the side of a regular figure and the radius of the circle in which it can be inscribed, or about which it can be described, is a constant quantity, and not quite equal to the ratio of $\frac{\frac{1}{20} \text{ of } 10 \text{ ft.}}{\frac{1}{2} \text{ ft.}}$, or $\frac{6 \text{ in.}}{20 \text{ in.}}$, or ·3.

Let AOB be one of the isosceles triangles, of which O is the vertex. From O draw OD perpendicular to AB. The angle AOB is $\frac{1}{20}$ of 360° or 18°, and ∴ the angle DOB is 9°. But the ratio $\frac{BD}{BO}$, when BOD = 9°, is (the table tells us) ·1564... If, therefore, BO = 20 in., BD = 3·128..., and not 3 in., as given in the problem. The perimeter ought to be 3·128... × 40, or 125·12... in., or 10·42... ft., instead or 10 ft., as given.

If, on the other hand, the 10 ft. be retained as the perimeter,

then the long side of the isosceles triangle would be 19·18 ... in., instead of 20, as given.

This problem, as given, as well as its corrected answer, is about as accurate as a question on the area of a circle would be were we to assume the ratio between the circumference of a circle and its diameter to be 3·13 instead of 3·1416 ...; it having been assumed that the ratio between half a side of the figure and the radius of the circle in which it was inscribed is ·15, and not ·1564.

6 STUDENT.—With the notation of Arts. 134, 135, 136, establish the following result:—

$$r = \frac{a-b}{\cot\frac{B}{2} - \cot\frac{A}{2}}.$$

(*Todhunter's* 'Trigonometry for Beginners,' Ex. XVI., No. 22.)

$$BD = r\cot\frac{B}{2},$$

$$AE = r\cot\frac{A}{2},$$

$$\therefore BD - AE = r\left(\cot\frac{B}{2} - \cot\frac{A}{2}\right),$$

$$r\left(\cot\frac{B}{2} - \cot\frac{A}{2}\right) = (BD+CD) - (AE+CE)$$

$$= BC - AC$$

$$= a - b,$$

$$\therefore r = \frac{a-b}{\cot\frac{B}{2} - \cot\frac{A}{2}}.$$

7. GILLIES.—You will find the solution of your query in our issue for September, 1882.

8. PHILOS.—The solution of your query appeared in our issue for June, 1884.

9. RHYMNEY.—The solution of your query appeared in our issues for February, 1884, and April, 1885.

10. SAINT GUTHLAC.—'Xenophon's Anabasis,' 1 to 4 (Macmillan's Classical Series), *Bradley's* 'Arnold's Latin Prose Composition' (Rivington), 'Matthew's Gospel,' *Dr. White's* Text.

11. RIALEY HORSLEY.—In Latin there is no future tense of the passive infinitive; to supply its place the supine in *-um* is used after the present inf. pass. of *eo*, 'I go.' 'He said that the city would be taken,' '*Dixit iri captum urbem*' (see *Abbott's* 'Via Latina,' page 137). William Blake was the author of the 'Songs of Innocence.'

12. F. FAZAKERLEY.—No, not very many, but enough to alter one's position considerably. Try *Smith's* 'Principia,' Part II.

13. AJAX.—Large hand, 60; small hand, 85. Yes, you can sit for scholarship in July, and for the certificate in December, if you comply with the conditions.

14. GARCON.—Large hand, 50; small hand, 60.

15. OLD WELLSONIAN.—*Sully's* 'Psychology' (Longman), price 12s. 6d. *Fitch's* 'Lectures on Education' (6s. 6d.), *Loudan's* 'School Management' (Kegan Paul), price 5s.

16. PEASE-BLOSSOM.—Write to the Secretary, National School for Cookery, Exhibition Road, South Kensington, S.W., and ask for what information you require

17. J. E. H.—Large hand, 75; small hand, 80.

18. RELIQUES.—(*a*) Large hand, 63; small hand, 60); (*b*) large hand, 60; small hand, 60.

19. CLUPPINS.—In the case you mention, if you answer both you are certain not to get marks for more than one, and if the examiners are strict you may lose the marks for both.

20. A. B. H.—Address a letter to the Secretary of the Local Examination Scheme, Cambridge, and you will receive a prospectus containing all you want.

21. PANSY.—Large hand, 50; small hand, 55.

A and B do a piece of work in 4 days, B and C in 5 days, and A and C in 6 days; in what time would each do it alone?

A + B do $\frac{1}{4}$ in a day
A + C do $\frac{1}{6}$ in a day
$\therefore$ B − C do $(\frac{1}{4} - \frac{1}{6})$ or $\frac{1}{12}$ in a day
and B + C do $\frac{1}{5}$ in a day
$\therefore$ 2 B do $(\frac{1}{12} + \frac{1}{5}) = \frac{17}{60}$ in a day
$\therefore$ B does $\frac{17}{120}$ in a day
$\therefore$ B would do it alone in $\frac{120}{17} = 7\frac{1}{17}$ days
A does $\frac{1}{4} - \frac{17}{120} = \frac{13}{120}$ in a day
$\therefore$ A would finish it in $\frac{120}{13} = 9\frac{3}{13}$
Similarly C " " $\frac{120}{7} = 17\frac{1}{7}$.

22. C. B.—Choose a fresh *nom de plume*. We recommend you to get *Walker's* text-book on 'Political Economy' (Macmillan). *Fawcett's* 'Manual' is expensive (12s. 6d.), but excellent. Smaller books can be found, such as *Mrs. Fawcett's* 'Class-book,' and *Jevon's* 'Primer.'

23. J. H. SLADDIN.—*Jacob's* 'Elementary Greek Grammar, 1s. 6d. *Rushbrook's* 'First Greek Reader,' 3s. 6d. (Clarendon Press). Examine the questions set at the last four examinations.

24. BROOMSGROVE.—There is no need to get new books, though *Dr. Abbott's* 'Latin Prose through English Idiom' might well be added. The difficulty is for you to know whether the work you do is correct, and if not where it is wrong. For this it is absolutely necessary for you to have your exercises corrected by some competent person.

25. J. L. H.—Only students in training are examined in science in December. But you can be examined in May. We should advise you to try the first year's papers in 1886 and the second year's papers in 1887. *Le Français* is published monthly, at the price stated in our last number.

26. X. Y. Z.—We believe there is such a collection as you want in the 'Civil Service Arithmetic.'

27. BROADBRIM.—At present there is no book on the subject that will exactly cover the course. Dr. Carpenter has engaged to supply the want through this magazine. The first instalment is in the present number. We cannot yet recommend any book for the second subject. There are many good editions of Milton, one in the Clarendon Press series; the price of *Johnson's* 'Lives of Pope and Dryden,' in the same series, is 2s. 6d.

28. HALIFAX.—No.

29. J. S. DEWAR.—(1) All the questions set last May were published in the autumn, and can be had through any bookseller, price 6d. (2) From the Secretary of the college where you sat. (3) Write to the publisher in question.

30. HOPEFUL.—Try *Dr. M. Foster's* primer on Physiology, 1s., and *Tanner's* 4s. 6d. 'Manual on Agriculture' *Jules'* 'Perspective' is very good; 2s. 6d. 'Geometry' would be easier; price about the same. You would do well to follow our former advice. What, for instance, can one make of a sentence like this, 'Where do I apply for a seat, and what is my part to obtain one?' To be able to express what you mean in clear English is of the very highest importance.

31. S. E.—The total number of marks is not made known, and you cannot find it out. Large hand, 60; and small hand, 65.

32. HOMER.—Yes; get up all the four. The period of history is limited, see Syllabus. School Management is well treated in *Loudon's* 'School Management' (Kegan Paul), and *Fitch's* 'Lectures'; Algebra, *Todhunter's* 'Algebra'; Geometry, *Todhunter's* or *Casey's*; Political Economy, *Walker's* 'Political Economy' (Macmillan); *Mrs. Fawcett's* 'Class Book,' and *Jevon's* 'Primer.'

33. W. A. K.—New lessons are given at the certificate examination. Your case is exceptional. You will have to get permission to sit at the certificate examination. When you are writing to your inspector for it ask him where you will have to give the lesson.

34. S BASTIAN.—Large hand, 65; small hand, 80.

35. ANXIOUS ASSISTANT.—Your writing is good, but capable of great improvement. Large, 70; small, 75. The book-list is ample and excellent. Send testimonials from both teachers. Apply at once.

36. VIKYING.—'Geography,' *Mackay's* or *Hughes's*; 'Grammar,' *Daniell's* or *Dr. Smith's*; 'Arithmetic,' *B. Smith's* and *Capel's*; 'French,' *Macmillan's* 'Progressive Course,' or *Dr. Smith's*.

37. A. H. M.—For text-book use *Huxley* and *Martin's* 'Biology.' In your case *Howes's* 'Atlas of Biology' will be indispensable (Macmillan). The practical knowledge is almost impossible to get without help; could you not join some class? Write to Beck and Co., opticians, Tottenham Court Road, and tell them what you propose doing, and ask for the cheapest and best apparatus to work with. The practical work is an essential part of the examination. *Dr. Milnes Marshall's* small book on the 'Frog' will be most useful.

(Owing to pressure of space several queries are crowded out.)

Publications Received.

Cassell and Co., Limited—

The Citizen Reader.

Chambers (W. and R.)—

Chambers's Geographical Reader. Standard VII.

Educational Supply Association, Limited—

Social Economy for Children. Book ii. Arranged by E. E. Ellis.

'Class Subjects' Drawing Copies. Sets 1 to 5.

Illustrations of Natural Phenomena:—Avalanche; Iceberg, Glacier, and Aurora Borealis; Volcano and Geyser; Earthquake.

Heywood (John)—

Sound, Light, and Heat (Elementary Stage). By Alfonzo Gardiner.

Longmans and Co.

Longmans' New Readers. Standard IV.

Relfe Bros.—

Geometrical Drawing. By the Rev. J. H. Robson, M.A., LL.D.

The Public School Spelling Card.

Smith, Elder, and Co.—

The Cornhill Magazine. February.

Ward, Lock, and Co.—

English Grammar. By Lucy Toulmin Smith.

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Owing to numerous requests, we have been induced to start this Exchange Column for the benefit of our readers. We shall be glad to insert announcements relating to the 'Sale or Exchange' of books, etc., at the rate of ONE PENNY PER LINE, *prepaid.*

For sale:—Examination Arithmetic and Key, 4s.; Morell's Analysis of Sentences, 1s. 3d.; Hughes's Geography (quite new), 2s. 6d.; Barnard Smith's Examination Papers and Key, 3s. 6d.—Address, P. F., 1, Vine Villas, Victoria Road, Wanstead, Essex.

For sale:—5 vols. Blackie's Popular Encyclopædia, quite new and unsoiled, published price 11s each. Will take 30s. for the lot.—Address, Schoolmaster, 23, Woodford Road, Forest Gate, E.

For sale:—Cassell's Natural History, complete, 48 parts, cost 24s. Take 15s.—Teacher, 4, Castle Street, Stamford.

What offers?—PRACTICAL TEACHER (Vols. II., III., and IV.); Scholar (Vols I. and II.); Boy's Own Paper (Vols. I. to VI.); Cassell's Popular Educator, first 14 Parts just taken; 2 Wormwell's Arithmetics, with Key.—W. H. Small, Nelson Street, Buckingham.

For sale or exchange:—English Grammar and Analysis, by C. P. Mason, B.A. (3s. 6d.), for 2s. 3d.; Key to Goodacre's Arithmetic (6s.) for 3s.; New Testament in Greek for 2s.; Dr. Brewer's Guide to Roman History (3s. 6d.) for 2s.; all in excellent order. Sent post free.—C. A. Stanyer, 30, Newgate Street, Chester.

Wanted:—London University Calendars for 1876, 1878, 1879, 1880, 1881, 1883. State price for any or all.—W. Briggs, Fort Augustus, N.B.

What offers for—Common School Education (Currie), 6s.; Geography of the British Empire (Lawson), 3s.; and the Handy Atlas of the Counties of England (Philip), 3s. 6d. Together, or separately.—J. E. H., 1, Meadow Lane, West Derby, Liverpool.

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